STATE OF CALIFORNIA
EARL WARREN, Governor
DEPARTMENT OF NATURAL RESOURCES
WARREN T. HANNUM, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 49 JANUARY-APRIL 1953 Nos. 1 and 2

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

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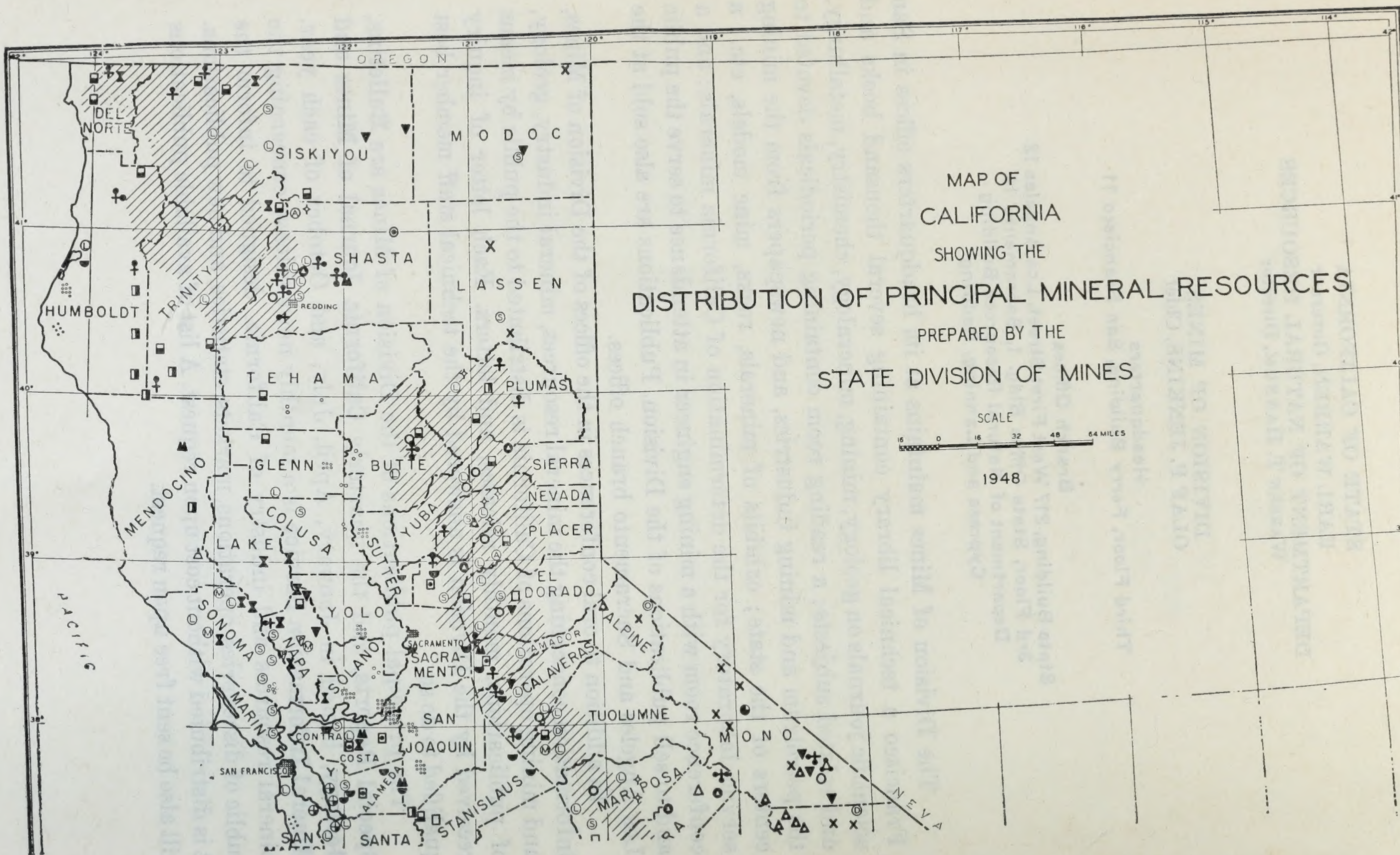
Headquarters
Third Floor, Ferry Building, San Francisco 11

Branch Offices
State Building, 217 West First Street, Los Angeles 12
3rd Floor, State Office Bldg. 1, Sacramento 14
Department of Natural Resources Building
Cypress and Lanning, Redding

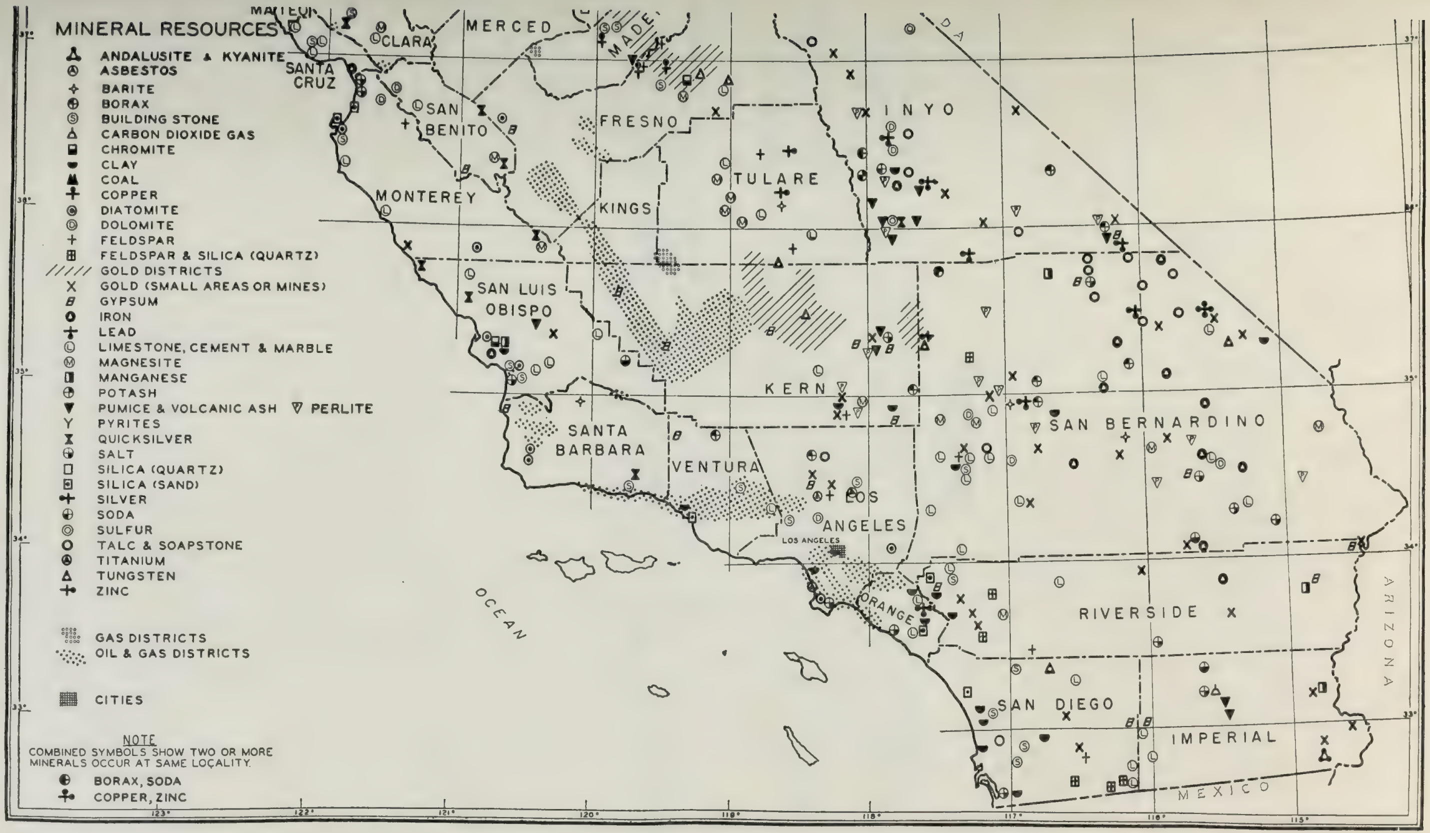
The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.



MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
DEL NORTE
SISKIYOU
MODOC
SHASTA
LASSEN
REDDING
HUMBOLDT
TRINITY
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
NEVADA
PLACER
MENDOCINO
COLUSA
YUBA
SUTTER
LAKE
EL DORADO
YOLO
SONOMA
NAPA
SOLANO
SACRAMENTO
AMADOR
ALPINE
CALAVERAS
TUOLUMNE
MONO
MARIN
SAN JOAQUIN
CONTRA COSTA
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SANTA
SAN
PACIFIC
NEVA



MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
MERCED
CLARA
SANTA CRUZ
SAN BENITO
MONTEREY
FRESNO
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN
123°
122°
121°
120°
119°
118°
117°
116°
115°
37°
36°
35°
34°
33°

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Plates

ANNUAL REPORT OF THE STATE MINERALOGIST
CHIEF OF THE DIVISION OF MINES

for the

103d Fiscal Year
July 1, 1951 to June 30, 1952

By OLAF P. JENKINS *

OUTLINE OF REPORT

Illustrations

* State Mineralogist and Chief of the Division of Mines, Department of Natural Resources.

LETTER OF TRANSMITTAL

General Warren T. Hannum
Director, Department of Natural Resources
Sacramento, California

Sir: I have the honor to transmit herewith for reference to Governor Earl Warren the annual report of the State Mineralogist, Chief of the Division of Mines, for the 103d fiscal year, July 1, 1951, to June 30, 1952.

This is in accordance with the requirement provided in the amended Section 2203 of the Public Resources Code.

In describing the activities of the Division of Mines, sections of the Public Resources Code are quoted, to give documentary evidence of what is required of the Division of Mines, and to show that the program it has followed adheres to the Code.

The following abstract summarizes some of the principal accomplishments of the Division during the fiscal year. As an index of its usefulness, the increase of 55 percent in the sale of technical publications is significant; also the distribution of the monthly pamphlet, Mineral Information Service, to 15,000 persons. Scores of letters of appreciation in the files show that the work of the Division has not been in vain.

The most noteworthy mining development in the state is in the advance of the nonmetallic minerals which are used in all manner of industries. The value of mineral production for 1951 reached the all-time high of \$1,166,909,000. The Division of Mines has held an important position by providing the public with authoritative information on mineral resources, mineral uses, and mineral industries.

Respectfully submitted,

Olaf P. Jenkins
State Mineralogist and
Chief of the Division of Mines

Ferry Building, San Francisco
September 1, 1952

ABSTRACT

Services of the Division of Mines have been improved, and have been extended to a larger number of people during fiscal 1951-52 than during any previous year. The publications which provide the Division with authoritative information have greatly increased in number and improved in quality. The backlog of material now ready for processing for publication has increased in amount, scope, and quality. On this account, the work load of staff members has increased, but has been well handled, since staff members are better trained. Careful consideration is given to integration of scientific work with its practical application and usefulness to industry and everyday life. This has been done through a systematic study of mineral utilization in industry, and through monthly staff conferences. The general appropriation for the Division increased scarcely 5 percent, while the accomplishments made notable strides.

Personal information and service were given as usual by letter, telephone, and conferences to thousands of individuals, but the work load required by these services has been controlled through the issuance monthly of Mineral Information Service, a pamphlet now being distributed to 15,000 people. Its wider distribution has caused wider distribution of the Division's more technical publications through sale, exchange, and donation to public schools and libraries. Publication sales for the fiscal year amounted to $28,963.55, which is an increase of 55 percent over the previous year. There is a notable increase in use of the Division's publications by other libraries.

The laboratory identified 3540 mineral specimens, a 12 percent increase over the previous year. The number of nonmetallic mineral samples has greatly increased in number as compared with metallic minerals. Most difficult to identify are the nonmetallics, which always require use of the microscope.

Division staff members attend public gatherings, serving as speakers and distributors of informational publications. About 200 meetings were attended during the year.

The Division's mineral utilization survey is making progress. Many industries using mineral materials have been visited, and the information secured has been systematically recorded. The value to industry of this work is proving to be even greater than was anticipated. It is planned that this program will be continued as a parallel undertaking with the Division's field survey of mineral commodities.

The geologic maps issued by the Division are all in great demand, especially by oil companies. The 1938 regional geologic map (scale 1:500,000) is out of print and a new state map must now be compiled; some progress has been made on this new regional map, scale 1:250,000.

It is apparent that the Division has played an important role in increasing the wealth of the state by distributing authoritative information to the public and by helping to solve special problems involving geologic background and other technical subjects. Unsolicited letters by the score have been received from the public commending the program and work of the Division. It is found that improved services always increase the demand for more services. Therefore, a normal growth of activities may be expected.

Semi-technical publications, such as geologic guidebooks and histories of mineral development and utilization have been very favorably received by the public. They have inspired appreciation of the mineral industry and its place in the general development of the state's economy and culture. These publications have also helped persons establishing new industries to understand the background of mineral development in California, and to respect her mineral resources as one of the foundations of the state's economic structure and traditions.

The increase in population and the growth of industry in California reflect directly upon the usefulness of the Division of Mines. A normal growth in its activities is in order to keep in step with the needs of a growing civilization. The total value of minerals produced in the state for the year 1950 was $1,146,411,000; that for 1951 is estimated at $1,166,909,000, which is the greatest annual production ever reported. The diversification of minerals used in industry is growing, especially the nonmetallic minerals utilized in the chemical and structural industries.

INTRODUCTION

Public Resources Code:

"2203. The State Mineralogist shall make an annual report to the Director for transmission to the Governor on or before the fifteenth day of September next preceding the regular session of the Legislature."

In reviewing the activities of the Division of Mines for the fiscal year 1951-52, the outline of its functional organization has been followed. In order to give documentary evidence of the fact that the Division's program of work adheres to the requirements of the Public Resources Code, passages of the Code are quoted throughout this report.

OUTLINE OF THE FUNCTIONAL ORGANIZATION OF THE DIVISION OF MINES

Administration Branch (San Francisco)
- Personnel control
- Office management control
  - Fiscal control section
  - Maintenance and service section
    - Stock and mailing
    - Mailing lists
    - Janitor service
- Publications control
  - Editorial section
  - Drafting and illustrations section

Geologic Branch (San Francisco)
- Mineralogic control
  - Public service laboratory section
  - Research laboratory section
  - Exhibits section
- Mineral commodity survey
  - Metallics section
  - Nonmetallics section
  - Mineral fuels section
- Geologic survey
  - Geologic mapping section
  - Guidebook section

Mining Engineering Branch (San Francisco)
(With small branches in Sacramento and Redding)
- Public information control
  - Library section
  - Information section
  - Mineral statistics section
  - Ore buyer's licensing
- Mining activities survey
  - County activities in northern California
- Mineral utilization survey
  - Mineral markets in northern California

Los Angeles Branch Office
- Public information control
  - Information, library, and exhibits
- Mining activities survey
  - County activities in southern California
- Mineral utilization survey
  - Mineral markets in southern California
- Geologic survey

FINANCIAL STATEMENT

Expenditures of the Division of Mines for the fiscal year 1951-52 show an increase of less than 5 percent over the fiscal year 1950-51. This increase hardly covers the advance in costs, prices of equipment, and salaries.

Expenditures of fiscal 1950-51	$373,600.00
Expenditures (estimate) of fiscal 1951-52	$391,245.43

Looking back over the years, it is found that the Division's annual appropriation has cost the state about three and one-half cents a year per person. In 1890 it was 3.6 cents per person; in 1951 it has been 3.5 cents per person. The population in 1890 was 1,213,398; now it is about 11,236,900. The value of the mineral production of the state in 1890 was a little over eighteen million dollars; now it is over one billion dollars. The assistance which the Division (then the State Mining Bureau) gave to the mining industry in the early days was largely for the prospector of precious minerals, especially gold. Now the Division of Mines renders service to the producers of industrial minerals, fuels, salines, etc. The great industries of the state are supplied with technical information regarding California's sources of raw mineral materials useful to them. The public is supplied with geologic maps and reports describing all manner of rocks and minerals, and their potential values. Schools and public libraries are provided with publications useful in educating the people of the state as to the geology and mineral resources of California. Therefore, the Division continues to function as a mineral information bureau; only the horizon of knowledge is broadened, and the techniques of discovery, identification, and use are improved.

ADMINISTRATION

Public Resources Code:

"2201. The State Mineralogist shall employ competent geologists, field assistants, qualified specialists, and office employees when necessary in the execution of the plans and operations of the division under this chapter."

The technical personnel of the Division of Mines is of the profession, comprised for the most part of *mining geologists*. Editors, illustrators, and librarians also have technical work to do. By July 1, 1952 the staff of the Division consisted of 52 employees—31 technical and 21 non-technical.

San Francisco headquarters office	
Technical employees	22
Non-technical employees	17
Los Angeles branch office	
Technical employees	6
Non-technical employees	2
Sacramento branch office	
Technical employees	2
Non-technical employees	1
Redding branch office	
Technical employees	1
Non-technical employees	1
Total	52

Administration of the technical work of the Division is centralized in the San Francisco headquarters office where assignments are made,

Financial Statement
*Fiscal 1951-52 **

Total salaries and wages		$215,632.63
Operating expenses:		
Freight, cartage, and express	$1,138.11	
Telephone and telegraph	1,860.68	
Toll calls	488.93	
Light, heat, and power	1,331.80	
Rent of building space	13,423.00	
Repairs and maintenance	781.58	
Office supplies and services	4,047.08	
Postage	6,333.50	
Photography supplies and services	1,162.89	
Blueprinting	513.42	
Printing bulletins and maps	62,608.67	
Printing, general	1,809.61	
Technical reports	10,100.00	
Auto parts and services, auto gas, oil, tires and tubes	6,151.18	
Travel	14,094.50	
Auto mileage	50.40	
Laboratory supplies and services	2,534.26	
Library supplies and services	748.04	
Exhibits supplies and services	483.43	
Total operating expenses		$129,661.08
Equipment:		
Automobile	$1,617.70	
Field	577.86	
Laboratory	152.32	
Library	3,240.34	
Exhibits	83.43	
Office	5,280.07	
Total equipment		$10,951.72
Total expenditures		$356,245.43
Special item: Geological exploration in cooperation with U. S. Geological Survey		35,000.00
Grand total		$391,245.34

* Some of the figures given are approximate, because not all bills for the fiscal year were paid at the time this report was prepared.

laboratory and library investigations are carried on, and reports are completed and processed for final publication.

Nearly all the great mining companies of the world have offices in San Francisco, and for this reason many technical mining organizations and mining committees meet and discuss mutual problems in this city. The Division of Mines benefits by its close association with this professional group of people. The bay area in general represents one of the great market centers of the world for mineral raw materials, and it has proved to be an important field of research for the Division's mineral utilization survey.

In addition to the headquarters office in San Francisco, the Division of Mines maintains offices in Los Angeles, Sacramento, and Redding. These offices are effective in extending the services of the Division to the public and in contacting local industry and research workers. The Los Angeles office is especially helpful in carrying on the Division's mineral utilization survey in that area, besides keeping in close touch with mineral producers of the south. Southern California is a center of extensive markets for raw mineral materials of the southwest. This ever-growing

industrial region appears to be unlimited in its capacity to use industrial minerals. The Division has effected closer understanding and contact between the producer of minerals in the state and the users of minerals.

The Sacramento office is in contact with the mining field of the Sierra Nevada and the growing industrial area of Sacramento. It particularly serves the public who come to the State Capitol for information. The Redding office follows the mining operations of northern California. In its office are also housed members of the United States Geological Survey, who are carrying on cooperative field geologic mapping in the immediate vicinity. The results of this work are published by the Division of Mines.

New technical employees of the Division are indoctrinated in its operations by starting work in the San Francisco office: in the laboratory determining minerals by chemical, physical, and microscopic methods; in the library reviewing technical literature; and in the public information office where the Division's publications are distributed to the inquiring public and research is carried on to answer the various questions asked. Finally, the employee is sent into the field, first to work under supervision of a more experienced mining geologist, later to be assigned problems to be solved independently. The results of all of the field investigations and office researches are recorded in written reports, most of which become available in publications of the Division.

In the preparation of condensed reports for Mineral Information Service, the Division's monthly pamphlet, a different technical employee is given the assignment each month. In this way the publication is prevented from becoming stale, and the employee is given the opportunity of presenting a summary on subject matter of particular current interest or of general educational value to an audience comprised both of laymen and specialists. The success of Mineral Information Service is attested by its broad distribution and by the scores of letters from enthusiastic readers commending the publication. Frequently requests are made for reprints of an issue, or for extra copies for distribution at meetings or in classrooms.

Since questions must be answered concerning all features relating to mineral commodities, each member of the technical staff is assigned a certain group of these commodities, such as the saline minerals, limestones and dolomite, the ceramic minerals, the rare earths, etc. The geology, mineralogy, utilization, economics, mining, and preparation for industrial use of each mineral must be understood. As a result of these assignments, a staff of mineral commodity specialists has been built, with responsibilities which inspire interest in the work of the Division and in the welfare of the state. New information received by the Division on any of these mineral commodities is given to the specialist, who in turn uses it in his current studies, thus enlarging his horizon of knowledge. The inquiring public is referred to these specialists and in this way may be assured of receiving authoritative and up-to-date information.

Once a month each employee supplies the Chief with a report of his activities and accomplishments during that period. Once a month the technical staff meets in the San Francisco office where current technical problems or new findings in the field are presented informally, and freely discussed. Often representatives of cooperating agencies and interested guests are present, who contribute to the discussions, thus helping to inspire interest and to broaden the field of knowledge. Thus the various phases of the work of the Division become better integrated and applied

to practical problems; thus a living interest is maintained. Cooperation with other governmental agencies is secured, duplication of endeavor is eliminated, and a better relationship is developed among research workers with mutual interests. The result is to inspire confidence in the value of the Division's work and its usefulness to the public.

PUBLICATIONS BY THE DIVISION OF MINES

Public Resources Code:

"2205. The State Mineralogist shall: . . . (h) Issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this state."

"2209. The State Mineralogist may fix a price upon and dispose of to the public all publications of the division, including reports, bulletins, maps, registers, or other publications. The price shall approximate the cost of publication and distribution. He may also furnish the publications of the division to public libraries without cost and may exchange publications with geological surveys, scientific societies, and other like bodies.

"2210. All money received by the division from sales of publications issued by the division shall be deposited at least once each month in the State Treasury to the credit of the General Fund . . ."

Four types of publications are issued by the Division of Mines. All except *Mineral Information Service* (sent gratis) are sold to the public at cost of printing. During fiscal 1951-52, $28,963.55 was received from sales of publications; this is an increase of about 55 percent over the previous fiscal year.

(1) *Mineral Information Service.* Monthly 8-page ($8\frac{1}{2}''$ x 11″) offset press pamphlet, distributed without cost upon request.

Through this medium, current information and news of mineral developments are given, statistics and markets are recorded without delay, announcement of new publications permits wider distribution of results of surveys, and a regular mineral commodity study of great interest to the public is reported. New industries have actually been initiated by this service. By the end of fiscal 1951-52, 15,000 copies were being printed each month, of which nearly 13,000 were sent to the regular mailing list and the remaining 2,000 were distributed from the information counters, at meetings, in answer to many written and oral questions, etc.

(2) *California Journal of Mines and Geology.* Quarterly periodical (paper covered, 6″ x 9″) sold separately ($1.00) or by annual subscription ($3.00). Through the medium of the Journal, an inventory of the mines of the state is recorded. County reports on the mines and mineral resources, reports on mineral utilization surveys, final statistical figures, and the annual report of the State Mineralogist are published in the Journal. Each county report is accompanied by a tabulated list of mining properties which is coordinated with a mineral map. In this manner the Division maintains a directory of all mines and significant properties of California.

(3) *Bulletins.* Published at irregular intervals (generally cloth covered, standard format 6″ x 9″, but other sizes also used); cover state-wide surveys, broad-subject monographs, and quadrangle geologic surveys; sold at cost of printing.

(4) *Special Reports.* A new series (paper-covered, $8\frac{1}{2}''$ x 11″), started in December 1950, covering subjects of special concern, but not of state-wide scope or of as broad scope as the Bulletin.

Through the medium of the Special Report the results of units of research are available without much delay. The $8\frac{1}{2}''$ x $11''$ page provides more room for tables, photographs, and maps than the standard Journal and Bulletin $6''$ x $9''$ page. The Special Report is becoming increasingly popular, and has relieved the overloading of the Journal with highly technical reports.

The following list gives the titles of all publications of the Division of Mines for fiscal 1951-52; it is divided into two parts as follows:

(1) Publications issued during fiscal 1951-52 (actually distributed to the public).

(2) Publications in press at close of fiscal 1951-52 (not ready for distribution on June 30, 1952, but in process of publication).

Since the authorship of reports is not limited to the staff of the Division of Mines, the affiliation of each author is shown by convenient symbols as follows:

C	Consultant, independent or commercial
CAS	Member, California Academy of Sciences
GS	Member, U. S. Geological Survey
SDM	Member, State Division of Mines
SI	Member, Smithsonian Institution
SWR	Member, State Division Water Resources
U	Member, University staff or student body

Publications Issued During Fiscal 1951-52

Mineral Information Service

Vol. 4, No. 7: Fluorescence; Use of term niobium; List of available Division of Mines publications.
No. 8: Black sands; Gold, silver, copper, lead, zinc production in California, 1950.
No. 9: Petroleum; Tungsten in Coast Ranges.
No. 10: Obsidian.
No. 11: Mineral filler; Barite; Production, utilization of petroleum.
No. 12: California mineral fillers; Index to Mineral Information Service, vol. 4, 1951.

Vol. 5, No. 1: California quicksilver mining during 1951.
No. 2: San Francisco Bay area issue.
No. 3: Outline of stratigraphic record in California; List of commercial assay and testing laboratories.
No. 4: Cement copper; Supplementary list of assayers.
No. 5: Copper; Recent developments in California cement industry.
No. 6: Use of fossils in geologic exploration; Price list of available Division of Mines publications; Clark Mountain area gypsum.

California Journal of Mines and Geology

Vol. 47, No. 3: July 1951: Mineral needs and problems of the bituminous base roofing industry, by Dozier Finley (C); Mines and mineral resources of Fresno County, California, by C. A. Logan (SDM), Lewis T. Braun (SDM), and James W. Vernon (SDM).
No. 4: October 1951: Mines and mineral resources of Contra Costa County, by Fenelon F. Davis (SDM) and James W. Vernon (SDM); Fluorspar in California, by James W. Crosby III (SDM) and Samuel R. Hoffman (SDM); Index to volume 47.

Vol. 48, No. 1: January 1952: Mineral needs and problems of the lead-acid storage battery industry in California, by Dudley Haskell (C); Mines and mineral resources of Glenn County, California, by J. C. O'Brien (SDM) and L. T. Braun (SDM); Annual report, Division of Mines, for the one-hundred second fiscal year, July 1, 1950 to June 30, 1951, by Olaf P. Jenkins (SDM); The mineral industry of California; its status and relation to national defense in 1950-51 (SDM).

No. 2: April 1952: Mines and mineral resources of Yuba County, by J. C. O'Brien (SDM); Supplement—Fabricas, by Elisabeth L. Egenhoff (SDM).

Bulletins

134. Part 3, Chapter 4, Chromite deposits of El Dorado County, California, by Fred W. Cater Jr. (GS), Garn A. Rynearson (GS), and Donald H. Dow (GS).

154. Geologic guidebook of the San Francisco Bay Counties: Preface, by Olaf P. Jenkins (SDM); Opening of the Golden Gate, by Dorothy G. Jenkins (SDM); Place names in the San Francisco Bay counties, by Erwin G. Gudde (U); Indians of the San Francisco Bay area, by Robert F. Heizer (U); Adobe houses in the San Francisco Bay region, by J. N. Bowman (C); Old lime kilns near Olema, by Adan E. Treganza (U); Geologic history of San Francisco Bay, by George D. Louderback (U); Development of the landscape of the San Francisco Bay counties, by Arthur David Howard (U); History of geologic investigation in the bay region, by V. L. VanderHoof (U); Geology of the San Francisco Bay counties, by N. L. Taliaferro (U); History of earthquakes in the San Francisco Bay area, by Perry Byerly (U); Geologic map of the San Francisco Bay region, by Oliver E. Bowen Jr. (SDM) and Richard A. Crippen Jr. (SDM); Prehistoric land animals of the San Francisco Bay region, by R. A. Stirton (U); Invertebrate fossils and fossil localities in the San Francisco Bay area, by Leo George Hertlein (CAS); Prehistoric forests of the San Francisco Bay area, by Ralph W. Chaney (U); California's contribution of mineral raw material to San Francisco industries, by Lauren A. Wight (SDM); Utilization of minerals in industries of the San Francisco Bay counties, by Charles Volney Averill (SDM); Salines in the bay area, by W. E. Ver Planck (SDM); Mineral fuels of the San Francisco Bay counties, by Gordon B. Oakeshott (SDM); Limestone and the cement industry of the San Francisco Bay counties, by Oliver E. Bowen Jr. (SDM); The building stone and aggregate industry of the San Francisco Bay counties, by Mort D. Turner (SDM); Volcanic rocks useful in the San Francisco Bay area, by Charles W. Chesterman (SDM); Clay and the ceramic industry of the San Francisco Bay counties, by Mort D. Turner (SDM); Ceramic education and industry in the San Francisco Bay area, by Joseph Pask (U); Manganese and quicksilver mineralization in the San Francisco Bay region, by Oliver E. Bowen Jr. (SDM); The New Almaden quicksilver mines, by Edgar H. Bailey (GS); Serpentine and chromite deposits of the San Francisco Bay counties, by Francis G. Wells (GS); Magnesite mineralization of the Red Mountain district, by A. J. Bodenlos (GS); Diatom deposits, by G. Dallas Hanna (CAS); Surface water supplies in the San Francisco Bay area, by Robert L. Wing (SWR); Geology of the Farallon Islands, by G. Dallas Hanna (CAS); Unusual minerals of the bay area, by Richard A. Crippen Jr. (SDM); Highways and byways of particular geologic interest, by Oliver E. Bowen Jr. (SDM); Glossary; Index.

159. Crystalline rocks of southwestern California: Crystalline rocks of the Corona, Elsinore, and San Luis Rey quadrangles, southern California, by Esper S. Larsen Jr. (U); Geology of the Cuyamaca Peak quadrangle, San Diego County, California, by Donald L. Everhart (U-GS); Ground water in the bedrock in western San Diego County, California, by Richard Merriam (U).

161. Geology of the Healdsburg quadangle, California: Geology of the Healdsburg quadrangle, California, by William Kelso Gealey (U); Mineralogy of the California glaucophane schists, by George Switzer (SI).

Special Reports

7A. Gem- and lithium-bearing pegmatites of the Pala district, San Diego County, California, by Richard H. Jahns (GS-U) and Lauren A. Wright (SDM).

7B. Economic geology of the Rincon pegmatites, San Diego County, California, by John B. Hanley (GS).

8. Talc deposits of steatite grade, Inyo County, California, by Ben M. Page (GS).

9. Type Moreno formation and overlying Eocene strata on the west side of San Joaquin Valley, Fresno and Merced Counties, California, by Max B. Payne (C).

10B. Nephrite in Marin County, California, by Charles W. Chesterman (SDM).

10C. Jadeite of San Benito County, California, by H. S. Yoder (C) and C. W. Chesterman (SDM).

11. Guide to the geology of Pfeiffer-Big Sur State Park, Monterey County, California, by Gordon B. Oakeshott (SDM).
12. Hydraulic filling in metal mines, by William E. Lightfoot (U).
13. Geology of the saline deposits of Bristol Dry Lake, San Bernardino County, California, by Hoyt S. Gale (GS-C).
14. Geology of the massive sulfide deposits at Iron Mountain, Shasta County, California, by A. R. Kinkel Jr. (GS) and J. P. Albers (GS).
15. Photogeologic interpretation using photogrammetric dip calculations, by D. H. Elliott (C).
16. Geology of the Shasta King mine, Shasta County, California, by A. R. Kinkel Jr. (GS) and Wayne E. Hall (GS).
17. Suggestions for exploration at New Almaden quicksilver mine, California, by Edgar H. Bailey (GS).
18. Geology of the Whittier-La Habra area, Los Angeles County, California, by Charles J. Kundert (SDM).
19. Geology and ceramic properties of the Ione formation, Buena Vista area, Amador County, California, by Joseph A. Pask (U) and Mort D. Turner (SDM).

Publications in Press at Close of Fiscal 1951-52

Mineral Information Service

Vol. 5, No. 7: Adsorbent clay; California mineral production, 1950; Mountain Pass rare earth operations; Production and utilization of petroleum in California during 1951; Clay in California; Clay research as an aid to industry.

California Journal of Mines and Geology

Vol. 48, No. 3: July 1952: California talc in the paint industry, by Richard S. Lamar (C); Geology of the Starbright tungsten mine, San Bernardino County, California, by George C. Hazenbush (SDM); Mines and mineral resources of Merced County, by Fenelon F. Davis (SDM) and Denton W. Carlson (SDM).

No. 4: Mines and mineral resources of Del Norte County, by J. C. O'Brien (SDM); Mineral commodities in California during 1950, by Henry H. Symons (SDM) and Fenelon F. Davis (SDM).

Bulletins

158. Development of the California landscape, by N.E.A. Hinds (U).
160. Geology of Saltdale quadrangle, California: Geology of the Saltdale quadrangle, Kern County, California, by T. W. Dibblee Jr. (C); Mineral deposits of the Saltdale quadrangle, by T. W. Dibblee Jr. (C) and T. M. Gay Jr. (SDM).
162. Geology of the Sebastopol quadrangle, California, by Russell B. Travis (U).
163. Gypsum in California, by W. E. Ver Planck (SDM).
164. Geology of Eel River Valley area, Humboldt County, California, by Burdette A. Ogle (C).
165. Geology of the Barstow quadrangle, California, by Oliver E. Bowen Jr. (SDM).
166. Geology of Lower Lake quadrangle, California, by James C. Brice (U).
167. Geology of Ortigalita Peak quadrangle, California, by Louis I. Briggs Jr. (U).

Special Reports

20. Geology of the Superior talc area, Death Valley, California, by Lauren A. Wright (SDM).
21. Geology of Burruel Ridge, northwestern Santa Ana Mountains, California, by James F. Richmond (U).
22. Geology of Las Trampas Ridge, Berkeley Hills, California, by Cornelius K. Ham (U).
23. Exploratory wells drilled outside of oil and gas fields in California to December 31, 1950, by Gordon B. Oakeshott (SDM), Lewis T. Braun (SDM), Charles W. Jennings (SDM), and Ruth Wells (SDM).
24. Geology of the Lebec quadrangle, California, by John C. Crowell (U).

25. Rocks and structure of the Quartz Spring area, northern Panamint Range, California, by James F. McAllister (GS).
26. Geology of the southern Ridge Basin, Los Angeles County, California, by Peter Dehlinger (U).
27. Alkali aggregate reaction in California concrete aggregates, by Richard Merriam (U).

Miscellaneous

Bull. 136, Supplement 1952—Minerals of California, by Joseph Murdoch (U) and Robert W. Webb (U).

Legal guide for California prospectors and miners, compiled under the direction of L. A. Norman Jr. (SDM), supplement to Mineral Information Service.

MINERAL LABORATORY

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a laboratory in San Francisco for the purposes provided in this chapter."

A total of 3,540 samples of minerals was received from the public and reported on by the laboratory of the Division of Mines during the fiscal year 1951-52. This is an increase of 12 percent over the fiscal year 1950-51. Continued interest was shown in strategic ore minerals of chromium, tungsten, manganese, copper, mercury, lead, iron, zinc, the rare-earth elements, and radioactive materials. Nonmetallic industrial mineral samples increased in number, as well as general interest in the various minerals which are used in construction and other industries.

Throughout the year, the Division's program of mineral commodity studies continued to draw heavily upon the research laboratory facilities and equipment. The petrographic microscopes were in constant use in making microscopic examinations of materials collected by staff members in connection with studies of clay, gypsum, asbestos, limestone, and perlite. Spectrographic analyses by the Division aided these investigations.

MINERAL EXHIBITS

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum . . . in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . .

(c) Make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes."

"2206. The State Mineralogist may prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the State."

The mineral exhibits of the Division of Mines continue to be of intense interest to visitors. During the school year, groups of children ranging in number from 15 to 100 passed through the museum and examined the many outstanding specimens currently on display.

The displays, containing approximately 21,100 labeled specimens, have been built up through generous donations by residents of the state and many other persons interested in preserving outstanding mineral, ore, and rock samples.

The task of relabeling and improving the appearance of the museum—especially in the cases containing the metallic and nonmetallic minerals—

is making good progress. An exhibit showing various phases of the mineral wealth of the state has been established in the new Capitol Annex in Sacramento.

Several members of the technical staff attended local and distant mineral shows and conventions, where they answered questions of the public regarding the geology and mineral deposits of California. Many of the Division's publications were also distributed at these meetings.

During the fiscal year 1951-52, 179 sets of forty specimens each of typical California minerals and rocks were distributed without charge to elementary schools throughout California. This is an increase of 25 percent over the previous year. At the end of the fiscal year, there remained 72 unfilled requests for these sets.

MINERAL ACCESSIONS

Public Resources Code:

"2204. The State Mineralogist may receive on behalf of this State, for the use and benefit of the division, gifts, bequests, devices, and legacies of real or other property and may use the same in accordance with the wishes of the donors. If no instructions are given by the donors, the State Mineralogist shall manage, use, and dispose of the gifts, bequests, and legacies for the best interest of the division and in such manner as he may deem proper."

The following specimens were donated during fiscal 1951-52 to the exhibits of the Division, and have all been cataloged.

21428 SCHEELITE ($Ca\ WO_4$), calcium wolframate in tactite. From Blue Star mine, Midpines, Mariposa County, California. Donor: A. G. Lietti, 1951.

21429 MONTAN WAX, a mixture of monohydric alcohol esters and high-molecular weight acids with some resinous and asphaltic material. Derived from lignite coal. From Ione, Amador County, California. Donor: Ione Corporation, American Lignite Products Division of Los Angeles Coal Company, 1951.

21430 POLYBASITE ($(Ag,Cu)_{16}Sb_2S_6$), silver antimony sulphide on quartz (SiO_2). From Bernice, Nevada. Donor: Mrs. Helen L. Halleran, 1951.

21431 ANTIMONY (Sb), native. From Erskine Creek, Kern County, California. Donor: Mrs. Helen L. Halleran, 1951.

21432 NEPTUNITE ($(Na,K)_2(Fe,Mn)(Si,Ti)_5O_{12}$), complex titano-silicate. From near headwaters of San Benito River, San Benito County, California. Donor: Mrs. Helen L. Halleran, 1951.

21433 BENITOITE ($BaTiSi_3O_9$), barium titano-silicate. From near headwaters of San Benito River, San Benito County, California. Donor: Mrs. Helen L. Halleran, 1951.

21434 TALC ($(OH)_2Mg_3Si_4O_{10}$), hydrous magnesium silicate. From Neal Mountain, Shasta County, California. Donor: Mrs. Helen L. Halleran, 1951.

21435 GREENOCKITE (CdS), cadmium sulphide. From near Topaz, Mono County, California. Donor: Mrs. Helen L. Halleran, 1951.

21436 ORPIMENT (As_2S_3), arsenic sulphide. From Getchell mine, Golconda, Nevada. Donor: Mrs. Helen L. Halleran, 1951.

21437 JADEITE ($NaAlSi_2O_6$), sodium, aluminum silicate. From Clear Creek, San Benito County, California. Donor: W. R. Bast, 1952.

21438 GOLD (Au), native. From the Brunswick shaft, Idaho-Maryland mine, Grass Valley, Nevada County, California. Donor: Earl C. Long, 1952.

21439 BASTNÄSITE ($(Ce,La,Di)(CO_3)F$), a fluo-carbonate of the cerium group of the rare-earth metals. From the Birthday claims, Mountain Pass, San Bernardino County, California. Donor: S. R. Hoffman, 1952.

21440 BASTNÄSITE ($(Ce,La,Di)(CO_3)F$), a fluo-carbonate of the cerium group of the rare-earth metals intergrown with Barite ($BaSO_4$), Siderite ($FeCO_3$), and Quartz (SiO_2). From the Birthday claims, Mountain Pass, San Bernardino County, California. Donor: O. E. Bowen, Jr., 1952.

21441 CERITE ($H_3(Ca,Fe)Ce_3Si_3O_{13}$), hydrous calcium, iron, cerium silicate. From Jamestown, Colorado. Donor: R. R. Redington, 1952.

21442 SCHROECKINGERITE ($NaCa_3(UO_2)(CO_3)_3(SO_4)F \cdot 10H_2O$), hydrous fluo-carbonate-sulphate of sodium, calcium, and uranium. From Wamsutter, Wyoming. Donor: R. R. Redington, 1952.

21443 CYRTOLITE ($ZrSiO_4$), zirconium silicate essentially, but contains uranium, yttrium, and other rare elements. From Colorado. Donor: R. R. Redington, 1952.

21444 URANOPHANE ($Ca(UO_2)_2Si_2O_7 \cdot 6H_2O$), hydrated silicate of uranium and calcium. From Lusk, Wyoming. Donor: R. R. Redington, 1952.

21445 SAUCONITE ($(Zn_{1 \cdot 95}Mg_{\cdot 12}Al_{\cdot 17}Fe_{\cdot 58})(Al_{\cdot 61}Si_{3 \cdot 34})O_{10}(OH)_2X_{\cdot 35}$), a zinc-bearing clay of the montmorillonite group. From Saucon Valley, Lehigh County, Pennsylvania. Donor: R. R. Redington, 1952.

21446 MONAZITE ($(Ce,La)PO_4$), a phosphate of the cerium metals. From Wodgina, Australia. Donor: R. R. Redington, 1952.

21447 CARNOTITE ($K_2(UO_2)_2(VO_4)_2 \cdot 3H_2O$), hydrated vanadate of potassium and uranium with Torbernite ($Cu(UO_2)_2(PO_4)_28\text{-}12H_2O$) in clay. From Imperial County, California. Donor: S. C. Wright, 1952.

21448 CHALCEDONY, var. CHRYSOPRASE (SiO_2), silicon dioxide with small amounts of nickel. From Amador County, California. Donor: Robert M. White, 1952.

21449 ANGLESITE ($PbSO_4$), lead sulphate. From Tintic Standard mine, Tintic district, Utah. Donor: R. B. Parry, 1952.

21450 MAGNETITE (Fe_2O_4), iron oxide. From Iron Springs, Iron district, Iron County, Utah. Donor: Parley Dalley, 1952.

21451 TEEPLEITE ($Na_2B_2O_4 \cdot 2NaCl \cdot 4H_2O$), hydrated borate-chloride of sodium. From Soda Lake opposite Sulphur Bank mine, Lake County, California. Donor: Peter Young, 1951.

21452 HEMATITE (Fe_2O_3), iron oxide. From the Sieguein mine, Mineral district, Washington County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21453 SPHALERITE (ZnS), zinc sulphide with Galena (PbS) and Pyrite (FeS_2). From the Pioneerville district, Boise County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21454 GALENA (PbS), lead sulphide interlaminated with Tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$). From the Minnie Moore mine, Blaine County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21455 GALENA (PbS), lead sulphide interlaminated with Tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$). From the Minnie Moore mine, Blaine County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21456 BORNITE (Cu_5FeS_4), copper, iron sulphide with Chalcopyrite ($CuFeS_2$). From the Snow Storm mine, Shoshone County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21457 BORNITE (Cu_5FeS_4), copper, iron sulphide with Chrysocolla ($CuSiO_3 \cdot 2H_2O$) and Malachite ($CuCO_3 \cdot Cu(OH)_2$). From the Peacock mine, Seven Devils district, Adams County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21458 CHALCOPYRITE ($CuFeS_2$), copper, iron sulphide with Pyrite (FeS_2). From the Blue Jacket mine, Crooks Corral district, Idaho County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21459 MALACHITE ($CuCO_3 \cdot Cu(OH)_2$), with Bornite (Cu_5FeS_4). From Seven Devils district, Adams County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21460 PYRITE (FeS_2), iron sulphide in quartz breccia. From Big Creek district, Idaho County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21461 NICCOLITE ($NiAs$), nickel arsenide with Galena (PbS). From the Nabob mine, Shoshone County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21462 ARGENTITE (Ag_2S), silver sulphide in Malachite ($CuCO_3 \cdot Cu(OH)_2$) and Chrysocolla ($CuSiO_3 \cdot 2H_2O$). From Rattle mine, Dahlonega district, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21463 CERUSSITE ($PbCO_3$), lead carbonate on iron-stained Quartz (SiO_2). From Hypotheek mine, Kingston district, Shoshone County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21464 GALENA (PbS), lead sulphide with Chalcopyrite ($CuFeS_2$), in Limonite ($Fe_2O_3 \cdot nH_2O$). From Hall Interstate mine, Deadwood Basin district, Valley County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21465 COBALTITE ($(Co,Fe)AsS$), sulpharsenide of cobalt. From the Beliel mine, Blackbird district, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21466 CHALCOPYRITE ($CuFeS_2$), copper, iron sulphide containing $35.00 per ton in Gold. From Lost Packer mine, Loon Creek, Custer County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21467 BAUXITE ($Al(OH)_3$), aluminum hydrate. From Mink Creek, Bannock County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21468 PHOSPHATE ROCK, a sedimentary rock containing substantial amounts of tricalcium phosphate ($Ca_3(PO_4)_2$). From the Waterloo mine, Bear Lake County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21469 ALUNITE ($K_2Al_6(OH)_{12}(SO_4)_4$), basic hydrous sulphate of aluminum and potassium. From Utah. Donor: Idaho Bureau of Mines, 1951.

21470 CALCAREOUS TUFA ($CaCO_3$), replacing willows. From the Sullivan Hot Springs, Custer County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21471 GYPSUM ($CaSO_4 \cdot 2H_2O$), variety known as Satin Spar. From Castle Creek, Owyhee County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21472 PHOSPHATE ROCK, a sedimentary rock containing substantial amounts of tricalcium phosphate ($Ca_3(PO_4)_2$). From Georgetown, Bear Lake County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21473 HALITE ($NaCl$), sodium chlorite, analyzed as follows:

$NaCl$ (Sodium chloride)	98.800 percent
$CaSO_4$ (Calcium sulphate)	00.917 percent
KCl (Potassium chloride)	00.261 percent
$MgCl_2$ (Magnesium chloride)	00.022 percent
	100.000 percent

From an unnamed locality in Idaho. Donor: Idaho Bureau of Mines, 1951.

21474 NITER (KNO_3), potassium nitrate. From Fairfield, Camas County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21475 FERBERITE ($FeWO_4$), iron wolframate. From Soldier Mountain, Camas County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21476 MONAZITE ($(Ce,La,Pr,Nd)PO_4$), phosphate of the rare-earth elements. Concentrate from Boise County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21477 WAD, amorphous manganese oxide. From the Paris mine, Bear Lake County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21478 MOLYBDENITE (MoS_2), molybdenum disulphide. From Roaring River, Elmore County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21479 FERBERITE ($FeWO_4$), iron wolframate and Hübnerite ($MnWO_4$), manganese wolframate. From the Nelson mine, Butte County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21480 MOLYBDENITE (MoS_2), molybdenum disulphide and Molybdite ($Fe_2O_3 \cdot 3MoO_3 \cdot 8H_2O$), hydrous iron molybdate. From the Mulke mine, Big Eight Mile Creek, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21481 CHALCOPYRITE ($CuFeS_2$), copper, iron sulphide. From the Dewey mine, Harpster district, Idaho County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21482 HÜBERNITE ($MnWO_4$), manganese wolframate. From the Ima mine, Patterson Creek, Lemhi County, Idaho. Donor: Bradley Mining Company, 1951.

21483 FLUORITE (CaF_2), calcium fluoride. From Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21484 SPHALERITE (ZnS), zinc sulphide. From the Paragon mine, Murray district, Shoshone County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21485 SMITHSONITE ($ZnCO_3$), zinc carbonate. From the Lake Creek mine, Blaine County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21486 CINNABAR (HgS), mercuric sulphide. From the Fern mine, Valley County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21487 STIBNITE (Sb_2S_3), antimony sulphide. From the Cosmopolitan mine, Owyhee County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21488 STIBNITE (Sb_2S_3), antimony sulphide with Stibiconite ($Sb_3O_6(OH)$?). From an unrecorded locality in Idaho. Donor: Idaho Bureau of Mines, 1951.

21489 STIBNITE (Sb_2S_3), antimony sulphide. From the Benton mine, Shoshone County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21490 ARGENTITE (Ag_2S), silver sulphide. From Silver City, Owyhee County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21491 SILVER (Ag), native. From the Black Tail district, Bonner County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21492 GOLD (Au), native in Limonite ($Fe_2O_3 \cdot nH_2O$) and brown Ocher. From the Gilmore mine, Texas district, Gilmore, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21493 GYPSUM ($CaSO_4 \cdot 2H_2O$), calcium sulphate. From Washington County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21494 TALC ($(OH)_2Mg_3Si_4O_{10}$), hydrous magnesium silicate. From the Pollock district, Idaho County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21495 CHYRSOCOLLA ($CuSiO_3 \cdot 2H_2O$), hydrous copper silicate with Malachite ($CuCO_3 \cdot Cu(OH)_2$) in crystalline limestone. From the Mackay district, Custer County, Idaho. Donor: J. Ray Weber, 1951.

21496 CHALCOPYRITE ($CuFeS_2$), copper, iron sulphide with minor amounts of gold, cobalt, and nickel. From the Uncle Sam mine, Blackbird district, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21497 CINNABAR (HgS), mercuric sulphide in Opalite. From the Idaho-Almaden Mines Company, Washington County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21498 SILVER (Ag), native in quartz that assays 859.5 oz. silver and 13.35 oz. gold per ton. From the Comeback mine, Boise County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21499 COBALTITE ($(Co,Fe)AsS$), sulpharsenide of cobalt in chlorite schist. From the Blackbird district, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21500 COBALTITE ($(Co,Fe)AsS$), sulpharsenide of cobalt with Hornblende ($Ca_4Na_2(Mg,Fe'')_8(Al,Fe''',Ti)_6Si_{12}O_{44}(O,OH)_4$) and Chalcopyrite ($CuFeS_2$). From the Blackbird district, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21501 BARITE ($BaSO_4$), barium sulphate. From an unrecorded locality in Idaho. Donor: Douglas Jacobs, 1951.

21502 MALACHITE ($CuCO_3 \cdot Cu(OH)_2$), basic cupric carbonate on Tile Ore, a brick-red earthy mixture of copper and iron oxides. From the Empire mine, Mackay district, Custer County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21503 BERYL ($Be_3Al_2Si_6O_{18}$), beryllium and aluminum silicate. From Deary, Latah County, Idaho. Donor: Mica Processing and Mining Co., Inc., 1951.

21504 GARNET (Concentrate from placer operations). From Warren, Idaho. Donor: Leland Wagner, 1951.

21505 VIVIANITE ($Fe_3P_2O_8 \cdot 8H_2O$), hydrous ferrous phosphate on Quartz (SiO_2). From the Blackbird district, Lemhi County, Idaho. Donor: Idaho Bureau of Mines, 1951.

21506 FLUORITE (CaF_2), caclium fluoride. From the Pungo claim, Valley County, Idaho. Donor: Edward Budell, 1951.

21507 STIBNITE (Sb_2S_3), antimony sulphide with Scheelite ($CaWO_4$). From Stibnite, Valley County, Idaho. Donor: Bradley Mining Company, 1951.

SURVEY OF MINERAL COMMODITIES

Public Resources Code:

"2200. For the purposes of this chapter 'mine' includes all mineral-bearing properties of whatever kind or character, whether underground, quarry, pit, well, spring, or other source from which any mineral substance is or may be obtained. 'Mineral' for the purposes of this chapter includes all mineral products both metallic and nonmetallic, solid, liquid, or gaseous, and mineral waters of whatever kind or character."

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State."

One of the most important continuing activities of the Division is to keep informed concerning the current developments of the state's mineral commodities (about 75 in number). For that reason the Division carries on general statewide surveys of mineral materials mined in California. Detailed field research is also under way on many of the more important of these mineral substances, including asbestos, cement, clay, feldspar, gypsum, kyanite, lead, limestone and dolomite, rare minerals, silica, massive sulfides, talc, and volcanic materials (obsidian, perlite, pumice).

During the 1951-52 fiscal year, the Division's statewide study of gypsum was completed and sent to press as a bulletin. It will include a summary of California's gypsum resources, of particular value to agriculture and the building industry.

Statewide clay studies were active during the fiscal year, resulting in publication of a special report on clays of the Ione district of Amador County. This report is the first in a series of such papers to be issued, dealing with the geologic occurrence and properties of commercial clays, and was done in close cooperation with the ceramics department of the University of California.

A statewide study on fluorspar was published in October 1951.

A report on steatite talc resources was in preparation at the close of the fiscal year, and a special report on the Superior talc area of Death Valley was in press. Further field work on talc resources has been completed and additional reports are in preparation.

Basic field work on perlite and pumice, important as lightweight aggregate materials, has been completed, and a bulletin is in preparation for publication.

Other mineral commodity studies previously initiated, on which progress was made, include asbestos, cement, dolomite and limestone, kyanite, rare minerals, and obsidian for optical glass.

The Division of Mines served the oil and gas industry by supplying copies of Bulletin 118, *Geologic formations and economic development of the oil and gas fields of California,* and reports and geologic maps of various areas and quadrangles. New publications which proved especially useful to the oil and gas industry include the following:

Special Reports 9 (*Type Moreno formation*), 15 (*Photogeologic interpretation*), 18 (*Geology of the Whittier-La Habra area*), and 19 (*Geology and ceramic properties of the Ione formation*). Several quadrangle map reports of interest to the petroleum industry were in press at the close of the fiscal year, and a large number of completed university theses were in the Division's files awaiting processing for publication.

A map of the state, on the scale of 1:1,000,000, showing locations of oil and gas fields and dry holes drilled outside the areas of published oil field maps was completed, together with a list of exploratory holes. This map and report (Special Report 23) are expected to be ready for distribution by September 1952.

BASIC GEOLOGIC MAPPING

The Division's program of basic geologic mapping of the state on the scale of approximately a mile to the inch was continued during the fiscal year 1951-52 with the publication of two new geologic reports and maps in the colored-lithograph 15-minute series; seven more were in press at the close of the fiscal year, and fifteen new quadrangles were in preparation. The colored lithographed geologic maps previously published con-

tinued in great demand by petroleum and mining companies carrying on exploration programs, as well as by engineers, agriculturists, and the scientifically interested public. Eventual objective is coverage of the state by geologic maps to be printed on the 15-minute topographic quadrangles issued by the Federal government. Some of the geologic field mapping is done directly by Division of Mines geologists, some by the Federal Geological Survey in cooperation with the Division, and some by professional geologists with various affiliations; the largest contribution has come through the geological departments of the large universities.

The following list shows progress of the basic geologic mapping program to July 1, 1952. The quadrangles listed are 15-minute (scale 1:62,500), unless otherwise indicated. The letter preceding the name of the quadrangle indicates the affiliation of the geologists who are doing the work:

D—Division of Mines
U—University geologist
S—Federal Geological Survey (cooperative program)
O—other professional geologist

The symbol (example, H 15) following the quadrangle name serves as a means of locating it on the index map (fig. 1).

Recently published geologic map and report:

(U) Antioch (K 16)
(U) Blue Lake (C 5)
(U) Carquinez (J 16)
(S) Cuyamaca Peak (F′ 37)
(O) Gaviota (R 31)
(U) Healdsburg (G 14)
(U) Jamesburg (L 23)
(O) Lompoc (Q 30)
(O) Los Olivos (R 30)
(U) Macdoel, 30-min. (I 1, I 2, J 1, J 2)
(U) Mare Island (I 16)
(U) Mount Vaca (J 15)
(S) Neenach (X 29)
(U) Petaluma (H 16)
(O) Point Arguello (P 30)
(O) Point Conception (Q 31)
(U) Point Reyes (G 16)
(U) Quien Sabe (N 21)
(U) San Benito (N 22)
(U) San Jose (E½)—Mt. Hamilton (W ½) (KL 19)
(U) San Juan Bautista (L 21)
(U) Santa Rosa (H 15)
(U) Sonoma (I 15)
(U) Tesla (L 18)
(U) Vacaville (K 15)

Geologic map published; report in preparation:

(U) Copperopolis (P 17)
(U) Hollister (M 21)
(O) Lake Elsinore (C′ 34)

Geologic map and report in press:

(D) Barstow 30-min. (C′ 29, C′ 30, D′ 29, D′ 30)
(O) Breckenridge Mt. (X 27)
(U) Ferndale (A 6)
(U) Fortuna (B 6)
(U) Lower Lake (H 13)
(U) Ortigalita Peak (O 21)

(O) Saltdale (A′ 27)
(U) Sebastopol (G 15)

Geologic map and report nearly ready for press:

(U) Dardanelles Cone (S 15)
(U) Mono Craters (N. half) (V 17)
(D) San Fernando (Y 31)
(S) Santa Catalina Island (X 35, Y 35)
(U) Sonora Pass (T 15)

Geologic map completed; report in preparation:

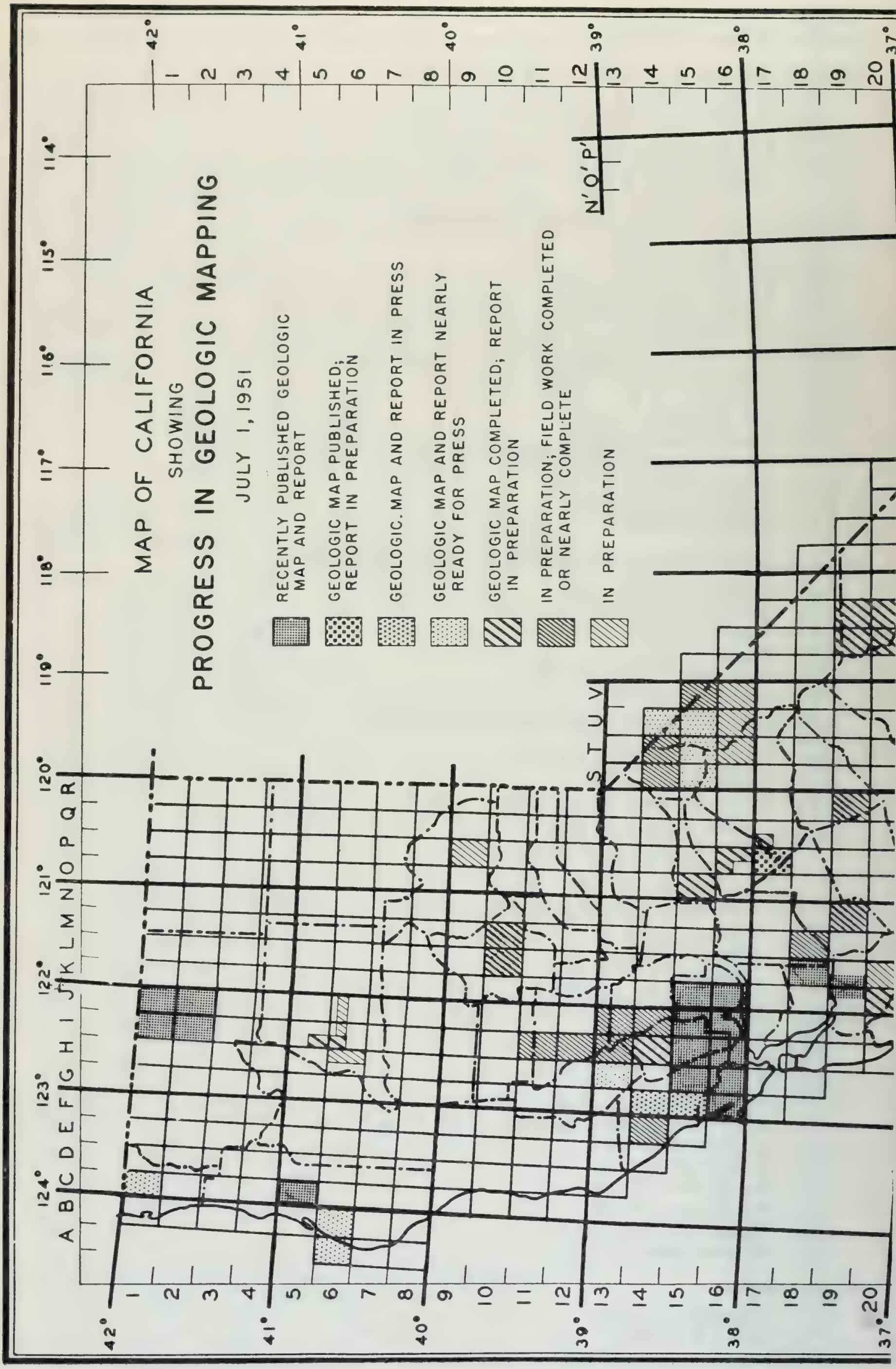
(S) Big Pine (Y 20)
(S) Bishop (Y 19)
(O) Fremont Peak (C′ 28)
(S) Mt. Goddard (X 20)
(S) Mt. Tob (X 19)
(S) New Almaden (K 20)
(S) New York Butte (A′ 22)
(O) Opal Mt. (D′ 28)
(S) San Andreas (P 16)
(U) Santa Ysabel (F′ 36)
(S) Shasta Copper Belt (I 5, 6)
(S) Sonora (NW$\frac{1}{4}$) (Q 17)
(U) Sutter Creek (O 15)
(S) Ubehebe (B′ 22)

In preparation; field work completed or nearly completed:

(U) Adelaida (O 26)
(U) Bradley (O 25)
(U) Bryson (N 25)
(U) Capay (J 14)
(U) Cape San Martin (M 25)
(U) Carbona (M 18)
(U) Cholame, 30-min. (Q 25, Q 26, R 25, R 26)
(U) Cuyapaipe (G′ 37)
(U) Desert Creek Peak (U 14)
(U) Ebbett Pass (S 14)
(O) Imperial Valley quadrangles
 Agua Dulce (H′ 35)
 Barrel Spring (H′ 36)
 Brawley (J′ 37)
 Carrizo Mt. (H′ 37)
 Coyote Wells (H′ 38)
 Durmid (I′ 35)
 Heber (J′ 38)
 Kane Spring (I′ 36)
 Plaster City (I′ 37)
(D) Masonic Mt. (V 15)
(U) Nipomo (Q 28)
(U) Orestimba (N 19)
(U) Paso Robles (P 26)
(U) Piedras Blancas (M 26)
(U) Priest Valley, 30-min. (O 23, O 24, P 23, P 24)
(U) St. Helena (I 14)
(U) Salinas (L 22)
(U) San Miguel (P 25)
(U) San Simeon (N 26)
(U) Topaz Lake (T 14)
(U) Wheeler Peak (U 15)

In preparation:

(U) Alvord Mt. (F′ 28)
(U) Banning (E′ 33)
(U) Big Bend Mt. (M 10)
(D) Bodie (V 16)
(U) Blairsden (P 9)


MAP OF CALIFORNIA
SHOWING
PROGRESS IN GEOLOGIC MAPPING
JULY 1, 1951
RECENTLY PUBLISHED GEOLOGIC MAP AND REPORT
GEOLOGIC MAP PUBLISHED; REPORT IN PREPARATION
GEOLOGIC MAP AND REPORT IN PRESS
GEOLOGIC MAP AND REPORT NEARLY READY FOR PRESS
GEOLOGIC MAP COMPLETED; REPORT IN PREPARATION
IN PREPARATION; FIELD WORK COMPLETED OR NEARLY COMPLETE
IN PREPARATION

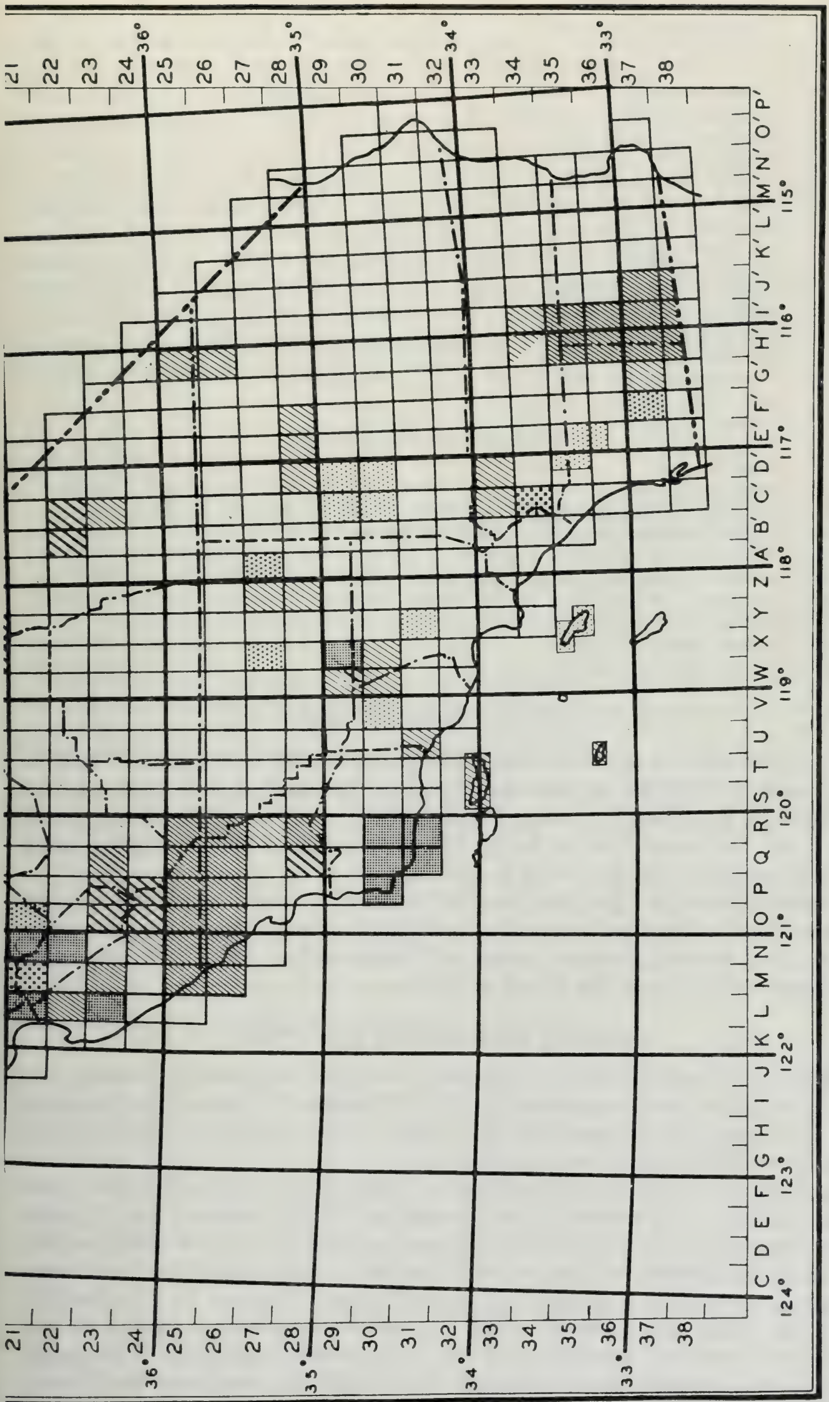

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FIGURE 1

(U) Branch Mt. (R 28)
(S) Casa Diablo Mt. (X 18)
(U) Coachella (H′ 34)
(U) Cottonwood Springs (I′ 34)
(U) Cross Mt. (Z 27)
(S) Darwin (B′ 23)
(U) Halfmoon Bay (I 19)
(U) Indian Gulch (R 19)
(U) Joaquin Rocks (Q 23)
(U) King City (N 24)
(U) Lane Mt. (E′ 28)
(U) La Panza (R 27)
(U) Lodoga (I 11)
(U) Lucerne Valley (E′ 31)
(D) Matterhorn Peak (U 16)
(U) Mojave (Z 27)
(U) Morgan Hill (L 20)
(S) New Almaden (K 20)
(O) New Idria (P 23)
(U) Oroville (L 10)
(U) Perris (D′ 33)
(U) Reiff (I 13)
(U) Rumsey (J 13)
(U) San Nicolas Island (T 35)
(O) Santa Cruz Island (S 32)
(U) Shadow Mts. (B′ 30)
(S) Shasta Copper belt (H 6, I 6, J 6)
(D) Shoshone (G′ 25)
(D) Tecopa (H′ 25)
(U) Triunfo Pass (W 32)
(U) Wilbur Springs (I 12)

STATE GEOLOGIC MAP

Compilation of a new regional state geologic map to replace the map of 1938, scale 1:500,000, is now under way. It is planned that the new state map will be issued on the scale of 1:250,000 in a series of adjoining sheets, which can be bound in atlas form. The sheets will cover one degree south to north, and two degrees west to east.

Demand for a state geologic map is very great, and it may be necessary to issue preliminary advance sheets without color, subject to correction, before final colored geologic maps are lithographed. The 1938 state map has been out of stock for about one year.

GEOLOGIC GUIDES AND HISTORIES

There is a growing demand among geologists, mineral collectors, and outdoor naturalists for guidebooks fully illustrated with maps, diagrams, and pictures, which describe the terrain, the geologic features and natural resources along routes of travel.

The Division's geologic guidebook, Bulletin 141, *The Mother Lode Country,* has gone through two printings (17,500 copies) and is now almost ready for a third printing. More recently *The San Francisco Bay Counties* guidebook, Bulletin 154, has been issued and has had very favorable reception. A smaller guidebook, Special Report 11, *Pfeiffer Big Sur State Park,* was issued in 1951. A guide to the physiography of the state, Bulletin 158, *Evolution of the California landscape,* is in press. Geologic guidebooks of the Klamath Mountains and southern California are planned, as well as a smaller guidebook of Point Lobos State Park.

The early history of the development of mineral resources, mining, and the utilization of minerals and rocks is of widespread interest and value to the people of the state. The Division has issued two such histories: (1) *The Elephant as they saw it,* which is a collection of contemporary pictures and statements on gold mining in California; and (2) *Fabricas,* which is a collection of pictures and statements on the mineral materials used in building in California prior to 1850. Each of these appeared as a supplement to the California Journal of Mines and Geology. In preparation are two more such histories, one on quicksilver mining and the other on hydraulic mining. These historic reports have proved to be much enjoyed and admired by the public, for development of the mineral industry is shown to be a part of the life and interest of the people of California, fundamental to the understanding and appreciation of present culture and future trends.

TECHNICAL LIBRARY

Public Resources Code:

"2205. The State Mineralogist shall: . . .

(d) Provide a library of books, reports, and drawings bearing upon the mineral industries, the sciences of mineralogy and geology, and the arts of mining and metallurgy, such library constituting the library of the division.

(e) Make a collection of models, drawings, and descriptions of the mechanical appliances used in mining and metallurgical processes.

(f) Preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours.

(g) Maintain, in effect, a bureau of information concerning the mineral industry of this State to consist of such collections and library, and arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it."

The value of the Division's fine technical library cannot be overestimated. It is used both by staff members and the public. It is maintained and kept up-to-date by a technical staff.

The classified books in the library on June 30, 1952, numbered 8,845. During the fiscal year 212 books were purchased, 21 received by exchange, and 52 received from donors. The library subscribes to 47 periodicals for the San Francisco office, 11 for the offices in Los Angeles, Sacramento, and Redding. There were 102 periodicals received on exchange. Altogether, 244 maps and charts were received.

The library served by helping staff members and the public find literature on technical subjects. There were 3,068 books and maps used by visitors; 2,658 used by staff members. The library maintains an interlibrary loan service; there were 17 outgoing and 4 incoming loans. Technical films were loaned to 17 groups. So-called "Teachers Kits," comprised of certain publications of the Division of Mines, were distributed to 76 schools. Publications of the Division, amounting to 800, were distributed to libraries. The list of libraries served was increased by 19. The exchange list receiving Division publications was increased by 10.

Through its exchange relations with the geological surveys and mining bureaus of the other states, the Canadian provinces, various national surveys, and learned institutions in this country and abroad, the library has received more than 500 separate publications during the year. These are not included in the list of classified books which accompanies this

report. The library is a depository for all the publications of the U. S. Geological Survey and U. S. Bureau of Mines. It also receives selected publications from many other research agencies of the Federal government. Important library holdings, maintained chiefly by exchange, include the publications of the American Geographical Society, American Institute of Mining and Metallurgical Engineers, American Petroleum Institute, Carnegie Institution of Washington, Geological Society of America, Geological Society of London, and the Institute of Mining and Metallurgy.

Exchange relations were resumed with the national geological surveys of Japan and Belgium, and exchange agreements were made with other institutions in Belgium, Germany, Australia, and Norway.

It has been found that the Division's publications are used more effectively in libraries if the librarian makes occasional visits to other institutions and discusses the use which may be made of the publications supplied. During the fiscal year, 23 libraries were visited and 8 professional meetings were attended by the librarian.

Research facilities have been extended by the addition of modern encyclopedia sets and basic bibliographic reference works, including Hawkins' *Scientific, medical and technical books published in the United States,* Downs' *American library resources, Cumulative book index,* the *American Library Association Guide to reference books,* and a number of subject bibliographies.

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INFORMATION SERVICE

Public Resources Code:

"2202. The State Mineralogist shall maintain offices, and a museum, library, and laboratory in San Francisco for the purposes provided in this chapter."

"2205. The State Mineralogist shall: . . . (g) Maintain, in effect, a bureau of information concerning the mineral industry of this State . . ."

The primary function of the Division of Mines is to disseminate information concerning the mineral resources of California. This is done most efficiently by widespread distribution of the Division's technical publications among individuals, libraries, industries, schools, and research groups. Inquiries for information are received by letter, telephone, telegram, and personal visits. To answer these questions requires much time and research on the part of Division personnel, because not all of the answers can be found readily available in books. Such information service is rendered by the headquarters office in San Francisco, and also by the other offices of the Division in Los Angeles, Sacramento, and Redding.

During the past year the majority of specific problems involved mineral raw materials utilized by industry. More producers and consumers have become aware of the fact that the Division may be used as a source of data for integrated studies of geology, mineral exploration, engineering, and mineral utilization.

National Defense has placed greater responsibilities upon the mineral industries than ever before. Known producing areas of raw materials have been re-examined and the search has been extended to many formerly nonproducing areas. California has been an active region in this search, and the Division of Mines has been an important source of information for those engaged in seeking the needed minerals.

Over 60,000 personal services, not including those of the library, were rendered by the Division of Mines last year. Of this number, 65 percent were handled by the headquarters office in San Francisco, 28½ percent by the Los Angeles office, and 6½ percent by the Sacramento and Redding offices. Outgoing mail amounted to over 200,000 pieces, and publication receipts from the State Printer totaled more than 325,000 pieces. Guided tours of the museum were provided for 78 groups of school children and youth organizations, totaling 2,552 persons.

Oral expressions of appreciation of the work of the Division of Mines are received constantly. Unsolicited letters from individuals, corporations, and governmental agencies pay tribute to the service and assistance of the Division in helping develop the mineral resources of the

state. The enthusiasm with which the public continues to receive Mineral Information Service is expressed in the steady increase in its circulation. The mailing list for this monthly publication now numbers 13,440. Requests to be placed on the mailing list for Mineral Information Service have been received at the rate of 10 per day.

Examples of the Division's services are: supplying information on mineral resources to various individuals, commercial concerns, and governmental agencies; providing technical speakers for meetings; identifying mineral specimens; keeping prospectors informed on the status of the assessment laws; referring mining engineers to available technical literature on special subjects; helping to establish contacts between companies and producers of minerals; assisting research workers to secure specimens from the field; helping out-of-state investors to find sources of raw mineral materials; helping various people to interpret and evaluate published technical information; providing maps and reports on geology and mineral resources of California. The results of such help are manifold, but value to industrial developments of the state cannot be measured in dollars and cents. Often the entire program of an industrial enterprise is based on fundamental information received from the Division of Mines.

PUBLIC APPEARANCES

At the request of various organizations, staff members of the Division frequently appear before gatherings to present educational talks or papers on special scientific subjects. The following organizations and meetings were attended by representatives of the Division during the fiscal year 1951-52. Nearly 200 such meetings were attended and in all cases some contribution was made by staff members of the Division. Often the Division's publications are announced or distributed during these meetings. Sales of publications during meetings total approximately $2300.00 for fiscal Year 1951-52.

Mining and geology (technical and advisory groups)

American Association of Petroleum Geologists (several papers were presented)
American Ceramic Society (paper was presented)
American Institute of Mining and Metallurgical Engineers (papers were presented and panel discussion given by Division of Mines staff members)
American Mining Congress (publications distributed and sold)
Association of American State Geologists (annual meeting)
California Hydraulic Mining Association (5 talks given; films shown)
Geological Society of America (papers were presented)
Los Angeles Chamber of Commerce Mining Committee
Mining Association of the Southwest
San Francisco Chamber of Commerce Mining Committee
Western Mining Council (talks given; information provided)

Fairs and mineral shows

California Federation of Mineralogical Societies Gem and Mineral Show
California State Fair (judged mining and mineral exhibits)
Los Angeles County Fair
Monterey Bay Mineral Society Annual Mineral and Gem Show
San Bernardino County Fair
San Diego Gem and Mineral Show
San Joaquin County Fair
San Luis Obispo Mineral Show
San Mateo Mineral Society Show

Representatives were in continuous attendance throughout the above fairs and shows, exhibiting mineral specimens, selling publications, and giving information on minerals and mining.

Mineral and geological societies

Calaveras Gem and Mineral Society (conducted field trip)
East Bay Mineral Society (talks given)
LeConte Geological Club
Los Angeles Lapidary Society (sold publications)
Mother Lode Mineral Society (talk given)
Northern California Geological Society (weekly luncheon meetings)
Northern California Mineral Society (talk given)
Pacific Mineral Society (talk given)
Palo Alto Geology Society (conducted field trips)
Sacramento Geological Society (films shown; talk given)
San Fernando Valley Mineral and Gem Society (talk given)
San Francisco City College Geological Society (talk given)
Santa Barbara and Ventura Mineral Societies (field trip conducted)
Shasta Gem and Mineral Society
Southern California Mineral Society (sold publications)
U. S. Army 21st Engineers geology group (talk given)

Educational

Alameda High School evening class in geology (talk given)
California Conservation Council
Carmel Adult Evening School (talk given)
Conservation of Natural Resources, Third Regional Conference
Inverness Grammar School (talk given)
Lassen County Teachers Institute (talk given)
Menlo College geology class (conducted field trip)
Oakland City Schools (talk given to elementary teachers)
San Francisco College for Women (talk given; conducted field trip)
San Francisco Josephine Randall Junior Museum (talk given)
San Francisco State College (conducted field trip for student teachers)
San Jose State College natural resources class (talk given; film shown)
Stanford University Department of Natural Sciences (open house)

Miscellaneous

Berkeley Wisemen's Club (talk given)
Boy Paleontologists, radio station KPFA (geologists interviewed)
California Library Association
Clay Conference, University of California (committee meetings; talks given)
Journal Club of Stanford University
Los Angeles County Chamber of Commerce
Montclair Church adult class (talks given)
Sacramento Valley Council of State Chamber of Commerce (talk given)
San Francisco Kiwanis Club (talk given)
Shell Development Research Club (conducted field trip)
Trinity Men's Club, Oakland (illustrated talk given)
Walnut Creek Cub Scouts (conducted field trip)
Walnut Creek Methodist Men's Club (motion picture films shown)
Walnut Creek Methodist Women's Club (talk given)
Western Museums Conference

ORE BUYERS' LICENSES AND INSPECTION

Public Resources Code:

"2250. It is unlawful for any person to engage in the business of milling, sampling, concentrating, reducing, refining, purchasing, or receiving for sale, ores, concentrates, or amalgams bearing gold or silver, gold dust, gold or silver bullion, nuggets, or specimens without first procuring the license provided for by this chapter."

"2253. The application for a license to carry on such business shall be made to the State Mineralogist . . ."

"2267. Every licensee under this chapter shall file monthly with the State Mineralogist a report of all purchases made under this chapter. The reports shall be made upon forms prescribed by the State Mineralogist and shall contain the information required by this chapter."

Two kinds of ore-buyers' licenses are issued by the Division of Mines: (1) Limited, limiting the buyers to $1,000 in purchases for the calendar year; (2) Unlimited, carrying no limit on purchases.

Licenses are issued by a calendar-year basis, nearly all of them being issued in January. To mid-July 1952, a total of 77 ore buyers' licenses was issued, of which 35 were unlimited and 42 limited.

MINERAL STATISTICS

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

"2207. The owner, lessor, lessee, agent, manager, or other person in charge of any mine of whatever kind or character within the State shall forward to the State Mineralogist, upon his request, at his office, not later than the thirty-first day of March in each year, upon forms which will be furnished, a report showing the character of the mine, the method of working the mine and the general condition thereof, and the total mineral production for the preceding calendar year. Any such person who fails to comply with the provisions of this section is guilty of a misdemeanor.

Such reports shall be confidential. Other records are public records unless excepted by statute. Statistical bulletins based on these reports and published under the provisions of Section 2205 of this code shall be compiled to show, for the State as a whole and separately for each county, the total of each mineral produced therein, provided that, in order not to disclose the production of any operator, no production figure shall be published which represents the production of less than three operators; and when such production figure for any county would conflict with such provision it may be combined with such production figures for one or more other counties. Such bulletins shall be published annually by June 30th or as soon thereafter as practical."

Mineral production data form an important tool to producers, public service groups, governmental agencies, and researchers. California mineral production statistics are compiled on a cooperative arrangement between the United States Bureau of Mines and the California Division of Mines. Initial publication of the figures immediately upon their receipt is in Mineral Information Service. A final summary, together with the pertinent facts relating to each mineral commodity are published in a subsequent issue of the California Journal of Mines and Geology.

Mine production of gold, silver, lead, copper, and zinc in California in 1950 appeared in the August 1, 1951 issue of Mineral Information Service; the complete 1950 production figures for all minerals, including county summaries, will be included in the July 1, 1952 issue of the same publication.

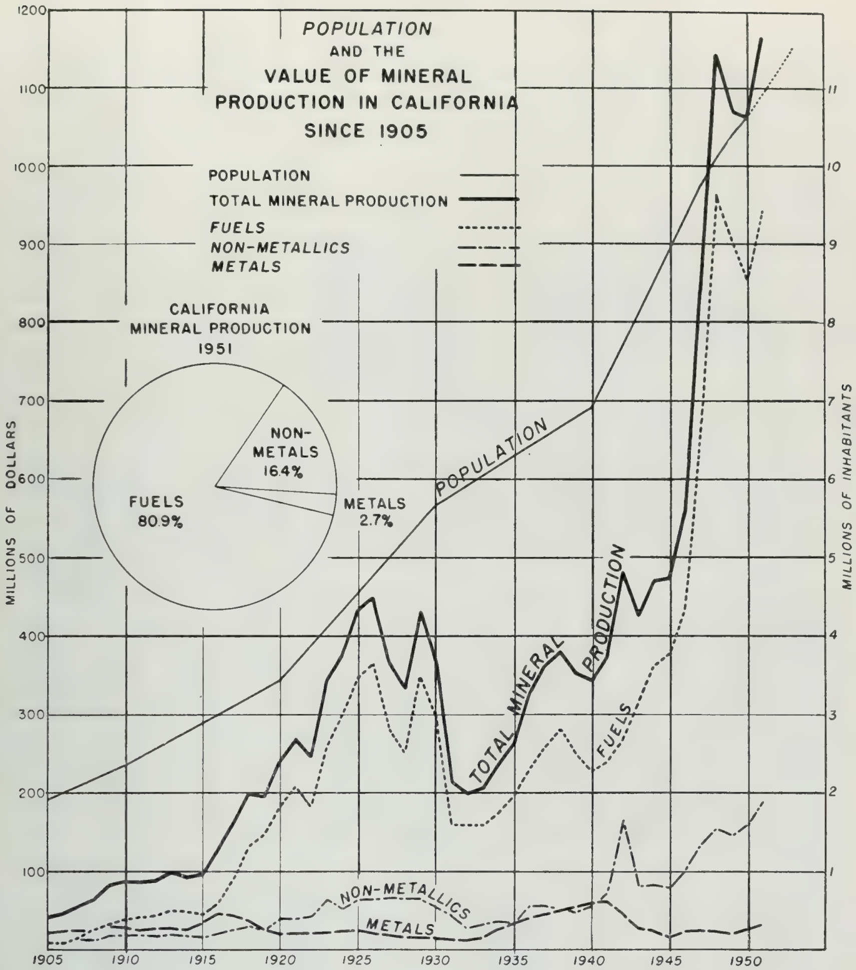

FIGURE 2

SUMMARY OF MINERAL PRODUCTION IN CALIFORNIA FOR THE YEARS 1950 AND 1951

The value of California's 1951 mineral output is estimated at $1,166,-909,000, the largest recorded annual production to date. The figure exceeds the 1950 output of $1,056,047,000 by $110,862,000 and the 1948 high of $1,146,411,000 by $20,498,000. Few final figures for 1951 are available at this time.

In both quantity and value, an all-time high was registered by cement, liquefied petroleum gases, miscellaneous stone, borates, and zinc; the values of lead and natural gas output were highest to date, and the quantity, but not value of petroleum exceeded the previous high during the year. Among the metals, gold and lead showed decreases, while silver, copper, mercury, and zinc noted above, showed increases. The highs reached by miscellaneous stone and cement again reflect the high demand for building materials for construction, both home and industrial.

Summary of Mineral Production in California for the Years 1950 and 1951.

Mineral commodity	Recorded 1950 production		Estimated 1951 production	
	Quantity	Value	Quantity	Value
Gold	412,118 fine oz.	$14,424,130	339,732 fine oz.	$11,890,620
Silver	1,071,917 fine oz.	970,139	1,145,219 fine oz.	1,036,481
Copper	1,292,000 lbs.	268,736	1,842,000 lbs.	445,764
Lead	31,662,000 lbs.	4,274,370	27,934,000 lbs.	4,832,582
Zinc	15,102,000 lbs.	2,144,484	19,204,000 lbs.	3,495,128
Mercury	3,850 flask	313,000	4,282 flask	899,777
Other metals, including chromite, iron ore, manganese ore, platinum, tungsten, molybdenum concentrate, titanium concentrate	----	6,946,000	----	9,505,000
Petroleum	327,607,000 bbls.	707,630,000	354,275,000 bbls.	795,492,000
Natural gas	558,398,000 M cu. ft.	66,449,000	544,997,000 M cu. ft.	66,490,000
Natural gas gasoline	21,246,677 bbls.	65,527,000	21,061,000 bbls.	64,236,000
Liquefied petroleum gases	7,081,848 bbls.	14,497,000	8,501,000 bbls.	17,427,000
Cement	26,685,004 bbls.	65,258,675	28,980,000 bbls.	74,729,000
Miscellaneous stone, including granite, limestone, diatomite, sand and gravel, crushed stone	----	49,546,000	----	51,400,000
Other industrial non-metallic minerals, including clay, gypsum, lime, pumice, sulfur, talc, pyrite, etc.	----	18,750,000	----	20,000,000
Borates	647,735 tons	15,890,000	862,797 tons	20,030,000
Other salines, including salt, soda ash, salt cake, bromine, calcium chloride, potash, iodine, and magnesium salts	----	23,158,000	----	25,000,000
Total value		$1,056,047,000		$1,166,909,000

SURVEY OF MINING ACTIVITIES

Public Resources Code:

"2208. The State Mineralogist or a qualified assistant may at any time enter or examine any and all mines, quarries, wells, mills, reduction works, refining works, and other mineral properties or working plants in this State in order to gather data to comply with the provisions of this chapter."

Statewide mineral commodity studies are supplemented by a continuing survey on a county basis of activities in mineral exploration, mining operations, and plant operations. These surveys enable the Division to maintain current information on mineral industry activities, and to publish the results as a summary of the mines and mineral resources of particular counties. A statewide summary of the mineral industry as related to National Defense in 1950-51 appeared in the January 1952 issue of the California Journal of Mines and Geology.

During the past fiscal year reports were published in the California Journal of Mines and Geology on the mines and mineral resources of Fresno, Contra Costa, Glenn, and Yuba Counties. A similar report on Merced County is now in press, and the manuscript completed for a report on San Bernardino County. Field work is presently underway for similar reports on Amador, Santa Clara, Los Angeles, Kings, and Monterey Counties.

Special reports on mining subjects are made available from time to time. A report on the economically important sand-filling method in underground mines, which has proved of great importance in some California gold mining operations, was published as Special Report 12, *Hydraulic filling in metal mines.* An article on copper recovery by precipitating copper on iron from copper-bearing waters appeared in the April 1952 issue of Mineral Information Service.

SURVEY OF MINERAL UTILIZATION

Public Resources Code:

"2205. The State Mineralogist shall:

(a) Make, facilitate, and encourage special studies of the mineral resources and mineral industries of the State.

(b) Collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use."

By means of questionnaires and plant visits, the Division of Mines is accumulating and making available pertinent data on the use of minerals by California industry. This work has progressed most extensively in the Los Angeles area, Santa Clara, San Diego, Monterey, Alameda, San Joaquin, and Sacramento Counties. In all cases, both the industry and the various Chambers of Commerce and trade groups have cooperated in this important work. In addition to the above source of mineral utilization data, staff members engaged in the mineral commodity studies are constantly contributing much information on the subject. Results to date show that there exists a definite need for a greater knowledge of mineral utilization to meet expanding industrial activity, demands resulting from the establishment of plants by out-of-state firms, changes in mineral raw material requirements as former sources become uneconomic or are depleted, and demands for such materials to meet requirements for new products and changing specifications.

Published reports by the Division on the subject of mineral utilization include *The mineral needs and problems of the bituminous base roofing industry*, and *Mineral needs and problems of the lead-acid storage battery industry of California;* both were prepared by representatives of industry and appeared in issues of the California Journal of Mines and Geology. A similar report on California talc in the paint industry is in press. Staff contributions, published in Mineral Information Service, include *Synthetic zeolite plant in San Bernardino, Adsorbent Clay, Salt industry of the bay area*, and *Mineral filler*. An article on minerals used in the glass industry of the Los Angeles area was completed.

BRANCH OFFICES

Los Angeles Branch Office. Proximity to a large and growing industrial area, which is surrounded by a region full of all manner of mineral deposits, makes Los Angeles and all of southern California a fertile field in which to develop a strong mineral industry of permanent economic value to the state. For this reason the Division's service office in the State Building, Los Angeles, has had an opportunity to accumulate a large amount of valuable data and to serve effectively an interested and growing population. Cooperation with the Los Angeles Chamber of Commerce Mining Committee resulted in its securing a large amount of information for the Mineral Utilization Survey.

Publications sold during the fiscal year 1951-52 by the Los Angeles office amounted to $4919.40, their value averaging nearly one dollar per volume. This is the highest annual total figure for publication sales in this office. Routine correspondence increased 97 percent. This, together with the newly organized Mineral Utilization Survey, increased the number of pieces of mail received from 2177 to 3921.

Preparation of the San Bernardino County report proved to be a very large undertaking. The Los Angeles County report progressed, and plans were made for other county reports.

Mineral commodity studies, in addition to talc, covered silver, lead, zinc, and gold in southern California; and tungsten, molybdenum, andalusite-kyanite-sillimanite, quartz crystals, talc, pyrophyllite, optical calcite, gem stones, beryl, and feldspar throughout the state.

Many contributions to Mineral Information Service were made by the Los Angeles office. Distribution of this pamphlet in the area increased 80 percent over the previous year.

Other field studies in southern California, particularly the geologic mapping of the Barstow quadrangle, were done under the supervision of the San Francisco office. Cooperation with the Federal Geological Survey and with other agencies was controlled from the San Francisco office.

Sacramento Branch Office. In Sacramento, the Division's service office, which is located in State Building No. 1, has increased its services considerably during fiscal year 1951-52. Though a small office, its correspondence amounted to 996 pieces, an increase of 94 percent over the previous year. Telephone calls increased 42 percent, and the number of office visitors increased 27 percent. The office contributed to Mineral Information Service, to county reports, to special studies, and was active in improving its mineral exhibits and in contributing to the California

State Fair by the building of a model mine. Several public gatherings were attended and talks were given.

The Sierra Nevada, containing as it does many problems in geology and mineral resources, offers a large and varied field for study, covering both metals and nonmetals. For that reason it is covered partly by the personnel of the Sacramento office and partly by that of San Francisco headquarters, where all the work is closely supervised. The Division is currently active in studying the clays and limestones of this important natural province.

Northern California. The large area of the Klamath Mountains, lying west of the lava fields of the Cascade Range and Modoc Plateau is not very well known geologically and not well developed economically. It offers, however, many opportunities in field problems of geologic mapping and in the study of potential sources of raw mineral materials for industry. The Division has now started a general reconnaissance field survey and intends to publish as the result of this work a series of geologic guidebooks of the region to enable the traveler and mineral-interested public to appreciate the possibilities of this vast rugged frontier country.

Though most of the Division's field studies of northern California are carried on under the direct supervision of the San Francisco office, its cooperative work with the Federal Geological Survey on massive iron-copper-zinc sulfides in the Redding area is centered in the Division's service office in the Natural Resources Building in Redding. In this office the Division rendered oral and written services during the fiscal year 1951-52 to about 2000 persons. A report on the mineral resources of Del Norte County was submitted for publication during the year and field work was under way on a similar report on Mendocino County at the close of the fiscal year. Mineral commodity studies of lead, zinc, pyrite, ferro-alloys, gold, silver, and platinum in northern California were also made. Schools and youth groups were provided information on California geology and mineral resources; county fair groups were provided data on mineral resources and information which they used in various exhibits and mineral shows.

REPORT OF THE U. S. GEOLOGICAL SURVEY ON COOPERATIVE PROGRAM *

Geologic investigations of mineralized areas of California by the Mineral Deposits Branch of the U. S. Geological Survey, under its cooperative agreement with the California State Division of Mines, continued at the same scale during the fiscal year beginning July 1, 1951, as in previous years. The total cost of the work was $111,000, of which the State contributed $35,000 and the Survey contributed the remaining $76,000. The investigations that were continued from the previous fiscal year include the Shasta copper, California chromite, Mother Lode gold, Bishop tungsten, Cerro Gordo-Ubehebe lead-zinc, and Darwin lead-zinc projects; late in the year, field work was begun on the new western Sierra foothills and eastern Sierra tungsten projects.

In addition to the cooperative investigations, the Mineral Deposits Branch continued its study of quicksilver deposits at its own expense, and the Geophysics Branch continued the natural potential, magnetom-

* By Edgar H. Bailey, geologist, U. S. Geological Survey. Publication authorized by the Director, U. S. Geological Survey.

eter, and geochemical studies of the Mammoth mine area that were recommended by geologists of the Mineral Deposits Branch as a result of the cooperative survey of the west Shasta area.

Late in the fiscal year the Mineral Deposits Branch began an extensive study, which will probably take several years to complete, in the Mojave Desert area. Because of the many geologists involved and the limited space available in the San Francisco office, it was decided to open a project office in southern California; suitable space was found in Claremont. Though this project is not a part of the cooperative program now under the direction of the San Francisco office, some geologists formerly assigned to cooperative work were transferred to it. The U. S. Geological Survey will benefit by having geologists who became familiar with the desert region under the cooperative program, and the State will benefit from the expanded scope of the investigations of the Mineral Deposits Branch in California.

The geologic mapping and appraisal of mines for which Federal funds for exploration or development were requested continued on an expanded scale through the year. This work is done by geologists of the Mineral Deposits Branch who utilize funds provided to the U. S. Geological Survey through the Defense Minerals Exploration Administration and Defense Minerals Procurement Agency. The Federal funds administered through the San Francisco office cover the work in both California and Nevada. As geologists from this office examined deposits in both states, the cost of the work in California cannot be calculated exactly, but it was about $25,000. During the fiscal year, 75 mine properties in California were examined, and, at the close of the year, 21 exploration contracts totaling $1,160,461.08 were in effect. About half of the deposits being explored under these contracts contain tungsten, but deposits of copper, lead, zinc, mercury, nickel, manganese, and asbestos are also being explored. Deposits containing uranium, antimony, iron, tin, mica, beryl, and rare earth minerals were examined, but contracts for their exploration had not bee approved at the close of the fiscal year.

Several deposits for which exploration funds were requested had been previously studied by the U. S. Geological Survey under the cooperative program, so that the project geologists were able to suggest specific areas most favorable for further exploration. The suggestions for drilling at the New Almaden mine, as published by the Division of Mines, are being closely followed in a Government participation project, and exploration of the Bully Hill-Rising Star mine in the Shasta district by diamond drilling in areas suggested by geologists of the U. S. Geological Survey has revealed significant quantities of ore.

Shasta Copper. Two parties have been assigned to the study of the large Shasta copper district. The party working in the western area devoted most of its time this year to the preparation of a comprehensive report, which was transmitted for critical review at the close of the fiscal year. The party in the east Shasta area completed the areal mapping and prepared geologic maps and cross sections of the mines. Laboratory study of ores and typical specimens of the geologic formations was in progress at the end of the fiscal year. A detailed report on the Bully Hill-Rising Star mine area was partly prepared, but, owing to the extensive diamond drilling that is being done in the area, it was decided to delay completion of the report until the geologic data obtained from the drilling program

can be incorporated. A detailed report on the Afterthought mine, completed at the close of the fiscal year, was revised.

California Chromite. The preparation of reports on the chromite deposits of California for publication as chapters of Bulletin 134 of the State Division of Mines was continued on a part-time basis. A report on the deposits of the northern Sierra Nevada was transmitted to the State Division of Mines for publication, and a second report on the chromite deposits of the southern Coast Ranges was revised after detailed review by the Washington staff.

Mother Lode Gold. The mapping of two adjacent $7\frac{1}{2}$-minute quadrangles was completed. A report on the San Andreas NW quadrangle was prepared and transmitted to the Washington office of the U. S. Geological Survey for review. The major mineral product now being mined in the area is limestone, and the geologic report indicates some large limestone masses that may be of commercial importance. A report on the more complex geology of the San Andreas NW quadrangle was nearly finished at the end of the fiscal year.

Bishop Tungsten. The geologist assigned to the study of the nationally important tungsten area near Bishop was able to devote only a part of his time to this project, as he was repeatedly called upon to assist in evaluating applications for exploration of tungsten deposits under the the DMEA program. Nonetheless, during the year economic maps of four 15-minute quadrangles were prepared, many kinds of rocks and ores were studied in the laboratory, and a report on the diverse metallic and nonmetallic mineral deposits of the area was begun.

Cerro Gordo-Ubehebe Lead-Zinc. The study of the Cerro Gordo (New York Butte) and adjacent Ubehebe Peak 15-minute quadrangles was continued on a reduced scale. The geologists assigned to the Cerro Gordo quadrangle, though able to devote only a small part of their time to this study, succeeded in preparing a summary report on the general geology, structure, and stratigraphy of the area.

The geologist assigned to the Ubehebe Peak quadrangle spent the entire year in the laboratory and office. A report on the Quartz Spring area, adjacent to the quadrangle, was transmitted to the Division of Mines for publication. A second report on the economic deposits of the Ubehebe Peak area, with pertinent mine maps, was virtually completed at the close of the fiscal year. This report summarizes the stratigraphy, structure, and igneous petrology of the quadrangle and emphasizes the relation between the geologic features and the mineral deposits.

Darwin Lead-Zinc. The geologic mapping of the Darwin 15-minute quadrangle, containing the highly productive Darwin lead-zinc mine, was continued through the fiscal year. Particular emphasis was placed this year on a detailed study of the geologic section as exposed beyond the limits of the Darwin mine, in anticipation of tracing these stratigraphic units into the mine area where the structures are more complex and the rocks are considerably altered. In addition, several smaller mines were mapped, and reports were prepared on the Lee, Cactus Owen, and Santa Rosa mines.

Eastern Sierra Tungsten. A new eastern Sierra tungsten project was begun near the close of the fiscal year. The first phase of the project will

consist of mapping the Casa Diablo 15-minute quadrangle, which contains the Black Rock tungsten deposit; this deposit is currently being explored under a large DMEA contract. Major emphasis is being placed on the study of the tungsten deposits, but the deposits of other economic minerals will also receive investigation.

Western Sierra Foothills. The new western Sierra foothills project, begun late in the fiscal year, is a continuation and expansion of the Mother Lode project; it includes a foothill copper belt as well as the Mother Lode gold belt. The initial phase will consist of mapping the southwest quarter of the San Andreas quadrangle, the other three quarters of which were mapped previously as part of the Mother Lode project. In the next phase the work will be conducted on a broader scale, with emphasis on deciphering the structure and stratigraphy of the belt by means of detailed studies along the major transverse canyons, which provide unusually good exposures.

San Francisco Office. The supporting staff of the Mineral Deposits Branch office in San Francisco at the end of the fiscal year, exclusive of Defense Minerals Exploration Administration personnel, was the same as that of the previous year. The two clerk-stenographers, one draftsman, and one scientific aide worked full time preparing text and illustrations for geologic reports and taking care of correspondence, accounting, and supplies for the geologic staff. During the year, 12 reports, containing 1,825 pages and 273 illustrations, were handled by the office staff. Four of these reports containing 498 pages and 55 illustrations (chiefly detailed maps), were transmitted to the Division of Mines for publication.

CONCLUSION

The accomplishments of the Division of Mines for fiscal year 1951-52 were considerably greater than for the previous year, though the cost of operation remained much the same. New members of the staff are now better trained and the objectives of the Division are better understood. Publication of a large number of excellent technical reports covering a broad field of knowledge has given the Division a strong background. Techniques have improved, the field of study is broader, and the audience has a larger sphere of interest. Integration of the various phases of the Division work is constantly improving; cooperation continues satisfactorily with outside agencies.

New problems in geology and in exploration for potential mineral resources develop as research is advanced. The possibilities of making much greater use of available minerals in the ever-expanding industrial fields seem unlimited. It is found that specifications for raw mineral materials now used by industry must be known in order to help the operator find and produce the needed minerals. This survey of mineral utilization has hardly started, but the results, even by the end of the fiscal year, were very encouraging.

The Division of Mines recommends that its program of work continue and be allowed to grow with expanding industry and population. Financial support should be commensurate with the new problems which now face the mineral industry and the rising demands of industry for raw mineral substances. A brighter outlook for the producer of minerals for industry is apparent.

MINES AND MINERAL DEPOSITS OF SAN BERNARDINO COUNTY, CALIFORNIA*

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OUTLINE OF REPORT

* Manuscript received for publication July 1, 1952.

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Illustrations

ABSTRACT

San Bernardino County, the largest in the United States, embraces an area of about 20,000 square miles lying mainly in the Mojave desert, a region of nearly barren mountain ranges, and dry, undrained basins. Within this region are rocks of almost every geologic age and type and many kinds of mineral deposits. About 45 mineral commodities have been produced in the county. Its 1950 mineral output, valued at $48,351,102, consisted of about one-half cement and other limestone products, one-third saline minerals, and one-sixth metallic and various other nonmetallic minerals.

Three of the 11 large cement plants in California lie within the county. These obtain limestone from pre-Cretaceous deposits in the Colton and Victorville-Oro Grande areas. Large, undeveloped reserves of limestone exist in other parts of the county.

The saline mineral industry in the county centers about Searles Lake playa where brine, pumped from the interstices of two huge crystal bodies, is treated at two plants which together recover one million or more tons of chemicals yearly. Here the American Potash and Chemical Company produces sodium sulfate, soda ash, potassium chloride, potassium sulfate, borax, lithium salt, and bromine; the West End Chemical Company produces soda ash and borax. Bristol Dry Lake, which once supported a gypsum operation, now yields large tonnages of salt from open cut operations; calcium chloride is won from the lake brine. Sodium sulfate formerly was recovered from the brine of Dale Lake. In the period 1894-1903 colemanite deposits in the Calico Mountains were the world's principal borate source. Large, little-developed reserves of gypsum, salt, and strontium minerals also exist in the county.

Talc deposits in pre-Cambrian rocks of the Death Valley-Kingston Range-Silver Lake region yielded about 60,000 tons in 1950. Several large-tonnage sand and gravel operations along Lytle Creek and the Santa Ana Rivers continued active. Significant tonnages of ceramic clay are obtained from altered zones in Tertiary rhyolite of the Castle Mountains. Deposits of pumice, perlite, and volcanic cinders are widespread in the county, but have not been extensively worked.

Of the metallic mineral resources, the Atolia tungsten deposits, which occur as veins in quartz monzonite and as placers, have been the most actively worked in recent years. Here lode deposits have been mined, in part, by newly introduced open pit techniques. The Starbright deposit, a scheelite-bearing tactite body northeast of Barstow, has been a significant source of tungsten since its discovery in 1949. Numerous other tungsten deposits throughout the county have been prospected or worked on a small scale.

Large tonnages of unusually rich silver ores were once obtained from veins in Archean schist near Randsburg and from veins in Tertiary sedimentary and volcanic rocks near Calico, but these operations are now dormant. Gold was formerly mined at many localities in the county, but the Bagdad-Chase mine, south of Ludlow, has been the only continuing operation in recent years.

Copper and lead-silver-zinc deposits, though widespread in the county, have generally proved small and have supported only short-lived or discontinuous operations. Two iron deposits, the Vulcan and Cave Canyon, have been extensively worked; several others have been explored or have been operated on a small scale. Several manganese deposits have been briefly worked; one near Owl Hole Spring has been the principal source.

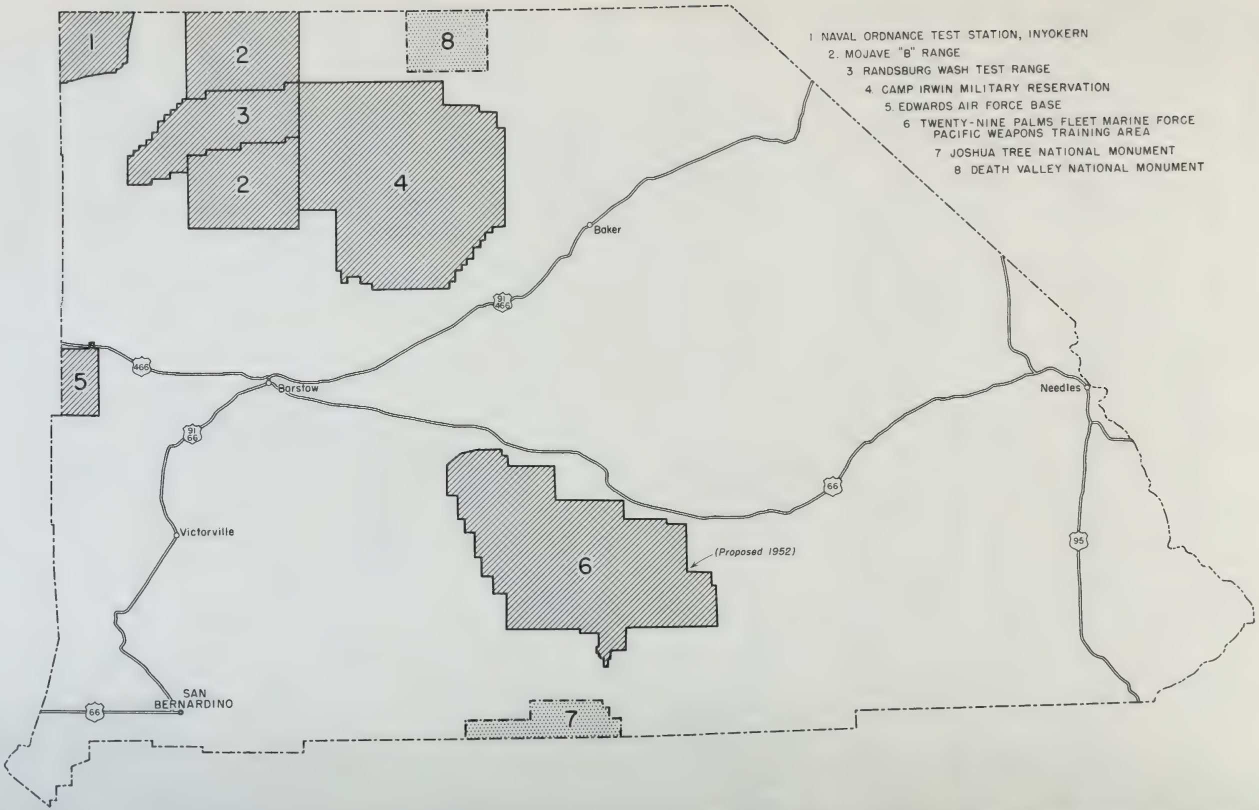

FIGURE 1. Outline map of San Bernardino County showing boundaries of national monuments and of areas withdrawn for military use. Except for Death Valley National Monument, these areas are not subject to prospecting or mineral location.

INTRODUCTION

Geographic and Cultural Features. The 20,157 square miles comprising San Bernardino County, the largest in the nation, embrace a vast inland region most of which lies within the sparsely inhabited Mojave Desert. The highest ranges, the San Gabriel and San Bernardino Mountains, contain several peaks 8,000 to 11,500 feet high. The two ranges trend eastward, end to end, in the southwest corner of the county.

The arable land, less than one one-hundredth of the county's total area, lies mostly in a belt of alluvial fans, low hills and fertile valleys that flank the steep southern slopes of the San Gabriels and San Bernardinos. Less extensive farm lands are scattered along the north flanks of these ranges and along a belt, about 30 miles long, bordering the Mojave River where it drains northward between the desert settlements of Victorville and Barstow. All but a small fraction of the county's population, 309,-330 in 1952,[1] is confined to these areas of relatively abundant water supply. The well timbered recreational areas in the upper parts of the San Gabriels and San Bernardinos receive heavy winter rain and snow; but the ranges act as barriers to coastal storms and thereby contribute to the aridity of the rest of the county.

Rather evenly distributed through the desert region are numerous mountain ranges, with steep, barren slopes, and generally from 1,000 to 3,000 feet in maximum relief. Most of the ranges are 10 to 20 miles long, although some mountainous belts, such as the one containing the Providence Mountains, the Mid Hills, and New York mountains in the east-central part of the county, are 50 or more miles long. Most of them trend northwest, but exceptions are common.

In general, the highest ridges and steepest slopes are underlain by ancient marine sediments of the Algonkian or Paleozoic eras, by granitic bodies emplaced in Mesozoic time, or by the more resistant of the Tertiary volcanic rocks. Characteristic along lower slopes and foothills are exposures of Archean crystalline rocks, of Tertiary sedimentary strata, and of the less resistant Tertiary volcanic rock.

Because the rainfall on most of the Mojave Desert averages less than five inches yearly, the region's drainage system contains little flowing water. Most of the desert stream channels and washes end in undrained depressions in whose centers lie the playas or dry lakes so familiar to desert travelers. The largest watershed is that of the Mojave River which originates in the San Bernardino Mountains, extends westward and northward through the Victorville and Barstow areas, and thence northward to the Mojave Sink in the center of the county.

Eight U.S. highways cut San Bernardino County. Of these, numbers 60, 70, and 99 traverse only the southwestern tip of the county. Numbers 395, 91, and 66 follow the same route northward through Cajon Pass, which separates the San Gabriel and San Bernardino Mountains. Thence 395 extends northward through Atolia and Red Mountain. Highways 66 and 91 divide at Barstow, the former routed northeastward through Baker, the latter eastward through Needles. Highway 466 joins 91 from the west at Barstow, and the two are coincident northeastward. Highway 95 parallels the Colorado River, and joins Blythe, Riverside County, with Searchlight, Nevada.

[1] Figure estimated by California Taxpayers Association.

The county is served by three railroads, the Southern Pacific, which extends across the southwestern corner of the county, and the Union Pacific, and Santa Fe, which follow the same route northward through Cajon Pass and Victorville. At Barstow the two divide, the Union Pacific extending northeastward, and the Santa Fe eastward. A branch of the Santa Fe extends westward from Barstow.

Several areas within San Bernardino County have been withdrawn from public domain for use by the Air Force, Army, or Navy. The boundaries of these areas are shown on the mineral deposit map, plate 1 and also in figure 1. While thus held, these areas are not open to prospecting or mining.

The Randsburg Wash test range and the Mojave "B" ranges are for use by the Department of the Navy. Lands within the Randsburg Wash range, withdrawn by Public Land Order No. 673 on October 6, 1950, will be acquired in fee by the Navy. Use of the lands within Mojave "B" range was granted to the Navy by two permits issued in 1943.

The lands within the proposed Fleet Marine Force Pacific Weapon Training Area, Twentynine Palms, had not been withdrawn by mid-1952, but plans were being laid to do so shortly thereafter. A condemnation action to obtain in fee the 2,400-acre camp site just north of Twentynine Palms had been filed on April 22, 1952.

Camp Irwin Military Reservation, containing nearly 640,000 acres, was temporarily withdrawn from public domain for use by the War Department (Department of the Army) by Executive Order No. 8507, dated August 2, 1950, and amended by Executive Order No. 9098, dated March 14, 1952. Over 21,000 acres of the total area was private land and has been leased to the government.

A small portion of Edwards Air Force Base extends into the western end of San Bernardino County near Adelanto. This Air Force base was withdrawn by Public Land Order No. 613, dated October 1949, Executive Order No. 8450, dated June 20, 1940 and Public Land Order No. 480, dated June 2, 1948.

The southern end of Death Valley National Monument extends into the northern end of the county but is open to prospecting and mining. Joshua Tree National Monument extends into the southern part of the county, in the vicinity of Twentynine Palms; this area is not open to mineral location.

Geological Features

Geologic History

Geologic formations of a wide variety of origins and ages are boldly displayed on the San Bernardino County landscape. The area includes the most extensive exposures in California of rocks of the earliest geologic era, the Archean or earlier pre-Cambrian. Most of the Archean units probably once existed as sediments, but early in geologic time they were transformed to the metamorphic rocks known as quartzite, schist, and gneiss. Also in Archean time, bodies of dark- to light-colored granitic rocks were emplaced.

Following the formation of the Archean units was a long interval, probably unrecorded in the rock sequence of San Bernardino County, when much or all of the land surface lay above sea level and was deeply

eroded. The eventual encroachment of a shallow sea, spreading at least into the northern part of the county, marked the beginning of the Algonkian or later pre-Cambrian era. Before the final retreat of this sea, a thickness of as much as 6000 feet of conglomerate, sandstone, shale, dolomite, and limestone was deposited. Large sills of the dark igneous rock, diabase, were intruded into the lower half of the Algonkian sedimentary section, probably before the upper half was deposited.

After a much shorter time interval than separated the Archean and Algonkian records, over the San Bernardino County area spread another shallow sea, confined, geologists believe, to a huge, trough-like depression trending north-northwestward across the western part of North America. This depression, known as the Cordilleran geosyncline, persisted throughout the Paleozoic era and into the following (Mesozoic) era and received a great volume of sediment which formed principally sandstone, shale, limestone and dolomite.

The San Bernardino County area probably lay near the center of the geosyncline, and the Paleozoic sediments here are unusually thick. Because different conditions of deposition existed from place to place across the width of the geosyncline, the Paleozoic sections, as exposed in the western, central, and eastern parts of the county, are dissimilar. At intervals the sea withdrew temporarily. Following its withdrawal in early Mesozoic time, there is no known record of its return except to the southwestern corner of the county where marine Tertiary sediments exist.

In the Mesozoic era, the Cordilleran geosyncline disappeared and the area it had occupied became dry land. The Mojave Desert contains a relatively small volume of sedimentary material deposited in Mesozoic time. Some of the marine and non-marine formations, characteristic of the Colorado Plateau of Utah and Arizona, extend into the northeast part of the county. Locally volcanic rocks are preserved. But the most noteworthy Mesozoic event in the California desert region was the abundant and widespread intrusion of granitic rock, probably near the end of the era and contemporaneous with the emplacement of the Southern California and Sierra Nevada batholiths to the west.

Of the early part of the Cenozoic era, little of the stratigraphic record remains in San Bernardino County. Probably in the early part of the Tertiary period (Eocene and Oligocene epochs) the area had a rather low relief and was drained by streams that carried the eroded detritus southward and westward beyond the present limits of the county. But in the following epoch, the Miocene, crustal disturbances and volcanic activity produced a more mountainous landscape. In the western and central parts of the county are preserved thick sections of Miocene non-marine strata deposited in basins probably, in large part, undrained and occupied by shallow lakes. The interior drainage and presence of borate minerals in some of the Miocene beds point to an arid or semi-arid climate.

Such conditions—mountain-building, basin-filling, intermittent volcanism, and aridity—seem to have persisted through late Tertiary into Recent geologic time. Non-marine, saline-bearing formations of proved or probable Pliocene age are widespread in the central part of the county. Though commonly highly deformed, the Miocene and Pliocene formations can be easily visualized as deposited in much the same way as the large playas so common in the Mojave desert of today.

Rock Units

Archean Rocks. As noted in the foregoing section, metamorphic rocks that have been assigned an Archean age are abundantly exposed in San Bernardino County; but they remain the least studied of any of the major units. Such rocks underlie many areas, commonly from 5 to 15 miles in maximum dimension, throughout the county.

The Archean units consist predominantly of micaceous schist, granitic gneiss, and quartzite; quartz pods and veins are common, as are dikes of various compositions. At most localities the Archean contains little or no carbonate rock, although a series of metamorphic rocks in the Piute and Old Woman Mountains [2] and the talc-bearing sequence in Silver Lake-Yucca Grove area, which has been tentatively assigned an Archean age,[3] do contain prominent units of carbonate rock. The talc in this area is genetically related to granitic rocks, also of probable Archean age. In general, however, the Archean units are not extensively mineralized; most of the mineral deposits that they do enclose appear to be much younger.

Noteworthy among deposits in Archean country rock are 1) the silver deposits near Randsburg, 2) several of the recently discovered rare-earth-bearing veins near Mountain Pass, and 3) the Vanderbilt gold veins in the New York Mountains, as well as numerous other gold-bearing quartz veins throughout the county.

Algonkian Rocks. In the north-central part of San Bernardino and the south-central part of Inyo County, the Archean complex is overlain by a series of distinctly less metamorphosed strata as much as 6,000 feet in total thickness and recognized as later pre-Cambrian (Algonkian) in age. These rocks, named the Pahrump series by Hewett,[4] appear to be restricted to a belt about 70 miles long, extending from the southeastern part of the Panamint Range eastward to the Kingston Range and southward at least as far as the Silurian Hills. At numerous localities in San Bernardino County, beyond the limits of this belt, Paleozoic or younger rocks are known to rest with depositional contact upon the Archean complex.

The Pahrump series, as defined by Hewett, is composed of three major units, the Crystal Spring formation, the Beck Spring dolomite, and Kingston Peak formation, with maximum measured thicknesses of 4200 feet, 1200 feet, and 2000 feet respectively.[5] The general lithology of the series is shown diagrammatically on plate 2.

Of greatest economic importance are zones of silicate minerals altered from Crystal Spring carbonate rock and bordering or near diabase sills. Within such zones are the deposits of commercial talc described in a following section. The Beck iron deposits, and some of the silver deposits

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[2] Hazzard, J. C., and Dosch, E. F., Archean rocks in the Piute and Old Woman Mountains, San Bernardino County, California (abstract): Geol. Soc. America Proc. 1936, pp. 308-309, 1937.

[3] Miller, W. J., Crystalline rocks of southern California: Geol. Soc. America Bull., vol. 57, pp. 457-548, 1946.

[4] Hewett, D. F., New formation names to be used in the Kingston Range of the Ivanpah quadrangle, California: Washington Acad. Sci. Jour., vol. 30, no. 6, 1940.

[5] For general data on the Pahrump series also see the following references:
Noble, L. F., Structural features of the Virgin Spring area, Death Valley, California: Geol. Soc. America Bull., vol. 52, pp. 949-950, 1941.
Wright, L. A., Geology of the Superior talc area, Death Valley, California: California Div. Mines Special Rept. 20, 22 pp., 1952.

in the Silurian Hills also have formed in the Crystal Spring formation. Otherwise the Pahrump series is notably free of known metalliferous mineral deposits of commercial interest.

Paleozoic Rocks. Paleozoic rocks are prominently exposed in most of the ranges of San Bernardino County. Their cumulative thickness is greatest in the north-central part of the county. Into this area extend Paleozoic units whose occurrence in the Nopah Range just north of the San Bernardino-Inyo County line, has been described by Hazzard [6] and Mason.[7] Here the Paleozoic section with a measured thickness of 22,875 feet, consists of about one-half dolomite and one-half limestone, quartzite, and shale in nearly equal proportions. The formations and their general lithology are shown on plate 2. Noteworthy is the unusual thickness of the Cambrian (about 16,600 feet), especially the Lower Cambrian (about 9,700 feet).

In San Bernardino County, units characteristic of the Nopah section, commonly in highly disordered blocks, are particularly extensive in an area embracing the Ibex Hills, the Kingston Range, and the Alexander Hills. The lowermost Cambrian, which throughout the western states ordinarily consists of quartzite and shale, is marked by a 1500-foot thickness of dolomite in the southern Death Valley-Kingston Range region. Here this formation, the Noonday dolomite, is much more widely exposed than any of the overlying Paleozoic formations; it contains virtually all of the lead-silver-zinc minerals in the region, whereas the others contain few, if any, metallic deposits of commercial interest.

East of the Kingston Range, in the Ivanpah, New York, and Providence Mountains the Paleozoic section is only 9,000 to 10,000 feet thick [8] and does not contain the large non-carbonate fraction occurring in the lower part of the Nopah Range section. Instead the sandstone and shale is confined to the lower 400 to 1200 feet; the lower one-third to one-half of the remainder is dolomite and upper part is limestone. In these ranges, the tungsten, copper, and lead-silver-zinc deposits ordinarily occur as replacement bodies in the Paleozoic carbonate units. The deposits are not restricted stratigraphically but are related in space to quartz monzonite intrusive bodies.

Only the upper part of the Paleozoic (Carboniferous and Permian) is shown to be represented in exposures in the Barstow-Victorville area, although some unfossiliferous, highly metamorphosed units may be lower Paleozoic in age.[9]

As noted in the description of limestone and dolomite deposits in this report, the 13,400 feet or more of Carboniferous and Permian strata in this area contain limestone units that are extensively worked as raw material for the cement industry of southern California.

Mesozoic Rocks. Sedimentary rocks of Mesozoic age are not extensive in San Bernardino County, but do exist in its northeastern part. Sections 4,000 or more feet thick, partly marine, partly non-marine, have been

[6] Hazzard, J. C., Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California: California Div. Mines Rept. 33, pp. 273-339, 1937.
[7] Mason, J. F., Geology of the Tecopa area, southeastern California: Geol. Soc. America Bull., vol. 59, pp. 332-352, 1948.
[8] Hewett, D. F., personal communication.
Hazzard, J. C., and Mason, J. F., Middle Cambrian formations of the Providence and Marble Mountains, California: Geol. Soc. America Bull., vol. 47, pp. 229-240, 1936.
[9] Bowen, O. E., personal communication.

noted in the region embracing Clark Mountain and the Ivanpah and Providence Mountains.[10] Metavolcanic rocks of Triassic or Jurassic age occur in the Newberry and Ord Mountains, and in the Victorville-Barstow area.[11] These rocks contain gold-bearing veins, including those at the Sidewinder mine described below. From place to place the Mesozoic volcanic rocks in the Victorville-Barstow area have been altered to pyrophyllite and to a fine-grained quartz-sericite mixture known commercially as Marter White.

The late Mesozoic granitic rocks, so abundant in San Bernardino County occur in numerous, widely distributed bodies. Some are as much as 50 miles long, but most are much smaller. Quartz monzonite is most common, but other types, ranging in composition from gabbro to true granite, are abundant. Metallic mineralization in the county is largely genetically related to these bodies. In Paleozoic carbonate rock that borders granitic rock, tungsten, copper, and lead-silver-zinc deposits have formed. Gold-bearing veins cut non-carbonate rocks near contacts with granitic rocks. Others that cut the granitic bodies probably formed soon after the rocks that enclose them. However, the Atolia tungsten-bearing veins, which cut Mesozoic quartz monzonite are believed to be Tertiary in age.[12]

Tertiary Rocks. Tertiary rocks, both volcanic and non-marine sedimentary, underlie wide areas of San Bernardino County. Of much more limited extent are the Tertiary marine strata, which exist in the vicinity of Cajon Pass and near Chino at the southwestern tip of the county. Miocene beds at the latter locality have yielded small quantities of petroleum.

Desert ranges composed largely or wholly of Tertiary volcanic rocks include the Calico Mountains north of Daggett, the Bullion Mountains south of Ludlow, the Castle Mountains near the Nevada border, and the Chemehuevi and Mohave Mountains in the southeastern corner of the county. The rocks range from rhyolitic to basaltic in composition. They form host rocks for silver deposits in the Calico district, and for gold deposits throughout the county. Altered zones in rhyolite of the Castle Mountains contain the clay deposits noted in a succeeding section. Also of commercial interest are the pumice and perlite deposits common in volcanic terranes in various parts of San Bernardino County.

The basins that existed in the county during the latter part of Tertiary time accumulated sediments as much as 10,000 feet thick. These are now moderately to highly deformed. Interbedded with the sandstone, shale, and tuff that form the bulk of the strata, are saline deposits of various types, including the borate deposits of the Calico district, the salt and gypsum deposits of the Avawatz Range and Owls Hole Spring areas, the celestite deposits near Ludlow, and the strontianite deposits northeast of Barstow.

[10] Hewett, D. F., personal communication.
Hazzard, J. C., Lower Triassic rocks in San Bernardino County, California (abst.): Geol. Soc. America Proc. 1936, p. 329, 1937.

[11] Gardner, D. L., Geology of the Newberry and Ord Mountains, San Bernardino County, California: California Jour. Mines and Geology, vol. 36, pp. 257-292, 1940.
Bowen, O. E., personal communication.

[12] Hulin, C. D., Geology and ore deposits of the Randsburg quadrangle, California: California Min. Bur. Bull. 95, 152 pp., 1925.

Quaternary Rocks. In Quaternary time large volumes of material have continued to be eroded from the desert ranges and to accumulate in undrained basins. Like the Tertiary strata, they are commonly saline-bearing, but are relatively undeformed. Volcanism also has continued but has been inactive during historic time.

Of greatest commercial importance are the crystal bodies and brines in the various playas noted in the saline section of this report. Alluvial sand and gravel deposits along the Lytle Creek and Santa Ana River channels provide large tonnages of aggregate material.

MINES AND MINERAL DEPOSITS

The material in this section is intended primarily to provide a balanced summary of the mineral industry of San Bernardino County, but could not include formal descriptions of all properties in the county. In general the operations or deposits chosen for description here were 1) those with the greatest past mineral yield, 2) those in current or recent operation, and 3) those about which there is little or no published data. A more comprehensive coverage is provided in the tabulated list at the end of this report.

All but a few of the deposits noted in this section were visited by one or more of the writers. Most of the northern one-third of the county and most of the San Bernardino Mountains were covered by Wright. Stewart's investigations included the southern part of the county, east of the San Bernardino Mountains, and the central part accessible from points on U. S. Highway 66 east of Barstow. Gay worked largely in the Calico and Goldstone districts and in the Ivanpah and San Bernardino Mountains. Most of the properties visited by Hazenbush were in the Victorville-Barstow area. S. R. Hoffman kindly assisted in studies of several sand and gravel operations and of several limestone deposits in the Cajon Pass-Victorville area.

Metals

Antimony

The only antimony produced in San Bernardino County was a very minor output in the years 1939 to 1942.[13] Several antimony deposits are known but appear to be small and of marginal importance.

Stibnite (antimony sulfide), the principal ore of antimony, has been reported in the Atolia, Calico, Clark Mountain, Rand, and New York Mountains districts.[14] Only the Desert Antimony mine in the Clark Mountain area, and described below, has been seriously worked.

Desert Antimony Mine. Location: sec. 18, T. 16 N., R. 14 E., S.B.M., at the east base of Clark Mountain, about 2½ airline miles northeast of Mountain Pass, and about 36 airline miles northeast of Baker. Ownership: Mrs. W. Trehearn, Nipton Mercantile Company, Nipton, California, owns 3 unpatented claims.

The Desert Antimony mine is the only property operated for antimony in San Bernardino County. It yielded small tonnages in the period 1927-28 and as late as 1939, but the mine has been inactive in recent

[13] Dolbear, S. H., Mineral production of San Bernardino County, 1880-1943, in Economic mineral resources and production of California: California Div. Mines Bull. 130, table facing page B-96, 1945.

[14] Murdock, J., and Webb, R. E., Minerals of California: California Div. Mines Bull. 136, p. 285, 1948.

years. A reduction plant consisting of a 10-ton furnace was installed on the property but was not put in continuing operation.

The deposits are stibnite-bearing quartz veins in Archean granitic gneiss. Three parallel veins, 2 to 5 feet wide and about 50 feet apart, strike N. 30° E. and dip 75° NW. The stibnite occurs as irregular aggregates and discontinuous stringers as much as 2 feet wide.[15] The veins also contain orthoclase and calcite. The ore as mined is reported to have carried from 15 to 20 percent antimony and to have been sorted to a grade of 40 percent.

Mining has been confined largely to the west vein, which appears richest in stibnite. A shaft, 100 feet deep, and inclined 75° NW., follows the vein. Several hundred feet of drifting explore the vein both north and south of the shaft on the 50- and 100-foot levels. For about 85 feet south of the shaft the vein has been mined to the surface. The middle and east veins have been explored by several hundred feet of surface cuts and shallow pits. Ore in the east vein is said to have been encountered by a short crosscut, winze, and drift totaling about 100 feet long.[16]

The mill house and concrete beds of the furnaces of the reduction plant were still standing in mid-1952.

Copper

Although San Bernardino County contains nearly one-fifth of the known copper-bearing localities in California, only 16,200,000 pounds of copper, less than 1.5 percent of the state's total, has been produced in the county. In 1950 the output was 219,300 pounds valued at $45,614, less than one-tenth of one percent of the total value of the county's mineral yield. The copper output exceded 1,000,000 pounds in 1889, 1900, 1912, and in the years 1916-1918.

Most of the copper has been obtained as a by-product of ores mined primarily for other metals. That the principal source of copper in San Bernardino County has been the Bagdad Chase gold mine is a fact not generally known.[17] The Bagdad Chase ore has averaged between 1 and 2 percent copper. Among the deposits mined mainly for copper, only those at the Copper World mine, Clark Mountain district, have a yield greater than 1,000,000 pounds. Those with a total output in the 100,000 to 1,000,000 pound range [18] are the Bell Gilroy (C. & K.), Emperor (Vulture), Express, Mohawk, New Trail,[19] Piute, Revenue, Standard, and Von Trigger.

Copper-bearing minerals are widely distributed throughout the county. Chalcopyrite is the principal copper-bearing mineral in most deposits, many of which are siliceous veins that cut Paleozoic or pre-Cambrian rocks. The Copper World deposits (see below) are an exception in that the copper minerals are largely secondary and are associated with zones of silication in dolomite. The copper at the Bagdad Chase mine is mostly in chrysocolla.

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[15] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 27, p. 264, 1931.
[16] Tucker, W. B., and Sampson, R. J., op. cit., p. 265, 1931.
[17] An output of less than 1,000,000 pounds is erroneously indicated in the following reference: Eric, J. H., Tabulation of copper properties of California, in California Div. Mines Bull. 144, p. 209, 1948.
[18] Eric, J. N., Tabulation of copper properties of California, in California Div. Mines Bull. 144, p. 208, 1948.
[19] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 37, p. 435, 1943.

Allured Mine. Location: sec. 22 (?), T. 15 N., R. 14 E., S.B.M., on the east side of the Ivanpah Mountains, about 8½ airline miles northeast of Mountain Pass and about 34 miles east of Baker. Ownership: Allured Mines Corporation, a Nevada corporation, Mildred J. Banks, vice-president, and Major E. Allured, 6233-B Benson Street, Huntington Park, California, secretary, owns 14 unpatented claims, all leased to John F. Erisman, Cima, California.

The Allured mine was developed mainly in the period 1925-40 when several hundred tons of silver-gold-copper ore were obtained. In 1947 and 1949 a small additional tonnage was shipped. The property consists of 3 groups of workings, none of them extensive. These have explored mineralized parts of faulted and sheared zones along contacts between granitic rock and Paleozoic sedimentary rocks.

The northeastern workings, on the Hillside claim, consist of a 20-foot tunnel and a 25-foot winze in an oxidized, pulverized fault zone with quartzite and limestone on the east and sheared granitic gneiss on the west. The winze opens into an east-west trending stope about 40 feet long, 15 feet wide, and 20 feet high, from which two carloads of ore, consisting of chalcopyrite in quartz and carrying 6 percent copper and some silver and gold, were removed.

The Oxide workings, about a half mile to the west, consist of several shafts on a copper-stained gouge zone between granitic rock, to the east, and limestone to the west. The main shaft is 135 feet deep, inclined 55° due west along the gouge zone. Several 40- and 50-foot drifts, totaling about 200 feet of level workings, penetrate the shear zone below the 70-foot level, mostly northward. A 30-foot vertical shaft penetrates the same zone 125 feet to the southeast, as does a caved airshaft 40 feet to the northwest. In 1947 one carload of ore mined from the 85-foot level averaged 8 percent copper and $6 or more in gold and silver.

Least extensive are the workings on the Cuprite claim, about a half mile southeast of the Oxide workings. Here an iron- and silica-bearing zone forms a bold outcrop on the granite-limestone contact. It is explored by several shallow shafts and a short tunnel from which no ore was removed.

B. and B. (Old Jackass) Deposit. Location: secs. 8 and 9, T. 11 N., R. 1 W., S.B.M., on a low ridge about 4 airline miles southwest of Lane Mountain and about 10 airline miles due north of Barstow, California. Ownership: Robert C. Buch and Elmer E. Mitchell, 851 W. Main, Barstow, California, own 4 claims of which all are leased to Clarence Morris, Pacific Mining and Milling Company, same address.

The B. and B. group is a small copper-silver-gold property with little production, if any. In early 1952 exploration and development work was renewed.

The mine is in low hills of deeply weathered Mesozoic granite rocks northwest of the Calico Mountains. Quartz veins as much as 2 feet wide strike westward and dip nearly vertically. Copper carbonates, chrysocolla, cuprite, argentite, and traces of cinnabar occur in the veins and in nearby weathered granite. The owners report that samples of sorted ore averaged 5-6 percent copper, 14-15 ounces of silver, and $2.80 in gold per ton.

The present owners have sunk a 70-foot shaft, inclined 80° N., with drifts about 20 feet east and west at the 30-foot level. Surface trenching

and 5 shafts from 15 to 20 feet deep explore the vein along several hundred yards of its exposed length. Older workings of limited extent also exist on the property.

Copper Basin Mine. Location: sec. 4, T. 2 N., R. 26 E., S.B.M., in the Whipple Mountains about one mile north of Monument Peak and immediately west of Copper Basin Reservoir. Ownership (1943): Charles L. Dunbar, Parker Dam, California, and Frank Ewing Estate own 8 claims.

The output of the Copper Basin mine has been quite small even though the property has been worked intermittently since 1906. During its early operation gold was produced from an oxidized zone of enrichment near the surface. During 1921-1922, the Copper Basin Consolidated Mines Company, J. S. Curtis, president, did most of the existing development work on the property. The first recorded shipment, made in 1930, consisted of 17.91 tons of ore which assayed 12.14 percent copper. In 1943, shipments totaled 53.48 tons assaying 3.27 percent copper. Total production from the property is probably less than 300 tons of ore.

Large quartz porphyry and diorite dikes underlie the mine area. These dikes strike north and dip vertically to 45° E. Several copper-bearing mineralized zones are exposed on the surface trending northwest. Two of these have been explored by shafts, cuts and short adits. Oxidation of the primary copper minerals, principally chalcopyrite with some bornite and chalcocite, has extended to depths of 80 to 100 feet. A gossan zone, containing oxidized copper minerals, extends south of east of the shaft area for several hundred feet.

A 300-foot shaft was sunk on one zone which strikes N. 30° W., dips 40°-45° E., and ranges in width from 5 to 40 feet. A 95-foot drift to the south on the 90-foot level is reported to have developed a sulfide orebody 65 feet long, 6 feet wide and assaying 5.2 percent copper.[20] The ore shipped in 1943 came from the dump of this shaft.

About 600 feet to the southwest, a nearly vertical shaft was sunk 100 feet on a zone striking N. 20° W., dipping 70° W., and having a width of 5 to 20 feet. An open trench extends 30 feet along the strike of the vein to the southeast. The ore shipped in 1930 came from this shaft, and some of the more recent activity by lessees has centered in this area.

The property has been idle since about 1949.

Copper King Deposits. Location: sec. 25, T. 15 N., R. 13 E., S.B.M., in the western foothills of the Ivanpah Mountains, about 8 airline miles south of Mountain Pass, and 31 airline miles east of Baker. Ownership: J. Riley Bembry, Cima, California, owns two unpatented claims.

Although rather extensively explored in the period 1900-10, the Copper King deposits remain prospects. Only small-scale work has been done since 1910. The workings lie along a sinuous granite-limestone contact.

Near the contact, a tactite zone three feet in maximum width is exposed in an L-shaped belt several hundred yards long. Three groups of workings on this zone are disposed at the corners of a triangle about 200 yards on a side. The tactite consists mainly of garnet, epidote, and iron oxides, and contains secondary copper minerals as coatings and seam fillings. According to one owner, it also contains gold.

[20] Tucker, W. B., and Sampson, R. J., op. cit., pp. 431-432, 1943.

The most extensive working is a shaft, inclined 70° northwestward, which is reported by the owner to be 225 feet deep. The other workings, though widespread, are shallow.

Copper World (Dewey, Ivanpah, Ivanpah Copper, Old Ivanpah Copper) Mine. Location: sec. 4, T. 16 N., R. 10 E., S. B. M., (projected) on the southwest flank of Clark Mountain, above 4 airline miles northwest of Mountain Pass, and about 31 airline miles northeast of Baker. Ownership: Ivanpah Copper Company, Dr. L. D. Godshall, president, 722 South Oxford Avenue, Los Angeles, California, owns 4 patented claims, all under lease to Collins and associates, 606 South Hill Street, Los Angeles, California.

The Copper World mine, a source of copper, lead, and silver in the period 1899 to 1920, has been relatively inactive since then. Much of the ore was treated at the company's smelter near Valley Wells about 5 miles southwest of the mine. The smelter has been long abandoned. In 1944 several thousand tons of old tailings were treated, and in 1949 copper furnace matte was shipped in a cleanup operation at the smelter site.

The copper minerals are associated with bodies of silicate minerals formed as alterations of Goodsprings dolomite near sill-like bodies of quartz monzonite.[21] The dolomite is widely exposed on the west side of Clark Mountain, where it has a general northwest strike and southwest dip, but in the mine area it is highly deformed.

The mine consists of two principal groups of workings, the Copper World workings, and the Dewey workings, about 1,500 feet to the southwest. The Copper World workings lie along a zone in which copper minerals, principally malachite and azurite, exist in veinlets and irregular bodies. The ore, as mined is said to have averaged 2 percent copper.[22] The principal Copper World workings consist of more than 2,000 feet of crosscuts, drifts, and winzes near the dolomite-quartz monzonite contact.

The Dewey workings, which lie along the same contact, consist of four tunnels driven along a vein that strikes N. 40° W., dips 40° to 60° SW., and is 4 to 8 feet wide. The tunnels are within a vertical interval of 150 feet and have a total length of several hundred feet.

Gold Hill Copper Mine. Location: sec. 27, T. 3 N., R. 23 E., S.B.M. (projected), on the west slope of Whipple Mountains, about 15 airline miles northwest of Vidal. Ownership: Harry Maddux and A. A. Baker, Beaumont, California, own 5 claims.

The Gold Hill Copper mine was operated on a small scale in 1904-1906; about 3 tons of ore were shipped in 1939. The ore was mined from quartz veins, 1½ to 4 feet wide. The veins are associated with diorite dikes that intrude schist. One set of dikes strikes northeast, the other northwest. The veins contain malachite, azurite, and chalcopyrite. The ore is said to have assayed 2 to 5 percent copper and to have contained traces of gold and silver.

Workings include an 80-foot vertical shaft, sunk in 1904-1906 by National Copper Company, with crosscuts driven north 15 feet on the 36-foot level, and south 50 feet at the bottom of the shaft. A vein, encountered in the shaft at the 26-foot level, is 4 to 6 feet wide. Fifty feet west of the

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[21] Hewett, D. F., personal communication.
[22] Tucker, W. B., and Sampson, R. J., op. cit., p. 433, 1943.

shaft, a vein less than 1½ feet wide is exposed in an open cut, and has been mined by a small stope. From this stope came the ore shipment reported in 1939. This was shipped to Hayden, Arizona, and assayed 5.45 percent copper, 0.425 ounce of gold and 54 cents in silver per ton.

Horn Mine. Location: approximately sec. 32, T. 2 N., R. 21 E., and sec. 5, T. 1 N., R. 21 E., S.B.M. (projected), on the southeast slope of the Turtle Mountains about 13 airline miles west of Vidal Junction. Ownership: Turtle Mountain Mining Company, A. Otis Birch, 427 West 5th Street, Los Angeles, California, and R. G. Van Horn, Box 547, Earp, California, owns 6 claims.

The Horn mine was probably opened in the period 1900-1908 during which it yielded an undetermined tonnage of copper ore during less than 1000 feet of exploration work. The present operators, who started work in 1951, have shipped copper ore that totaled about 200 tons by mid-1952.

The rocks in the mine area are Archean metamorphics, principally quartzite, gneiss and schist. One of the deposits is associated with a quartz-spinel rock which grades into a quartz-spinel-sericite schist. In the northern part of the mine area basalt locally overlies the metamorphic rock.

Copper ore minerals, principally chrysocolla with lesser cuprite, chalcopyrite and chalcocite, together with abundant silica have been deposited along fractures and have formed small replacement bodies along fault zones in the metamorphic rocks. Two parallel veins, about 200 feet apart, crop out on the southeast slope of a northeast-trending ridge; they strike N. 55° W. and dip vertically to steeply southwest. The vein to the northeast has been explored by surface cuts and by two short adits. The portals are 150 feet apart, one 70 feet higher than the other. The lower adit roughly follows the vein for about 90 feet; the upper adit was started on an ore body which was formed at the intersection of the vein and a strong cross fracture striking N. 70°-80° E. This adit was driven S. 70° W. following a mineralized zone along the cross fracture for 50 feet.

The vein to the southwest has been explored by a drift adit at an elevation 210 feet higher than the lower adit on the other vein. Ore has been found along the entire length of this adit (50 feet in mid-1952) and ranges in width from 2 feet to a maximum of 27 feet. The thickest part of the body apparently formed at the intersection of the vein and the same cross fracture explored by the upper adit on the other vein.

Four shipments totaling about 200 tons have been made. The grade of ore shipped has ranged from 4.84 to 6.71 percent copper, with small amounts of gold. Early in 1952, a loading ramp was constructed at Grommet and the last two shipments were made from there; earlier shipments were made from Parker.

Previous work on the property was on the northwest side of the ridge and included a 65-foot inclined shaft, a 525-foot adit and a 160-foot adit, with appended cross cuts, both driven S. 25°-30° E.

Little Mike Mine. Location: sec. 36, T. 14 N., R. 7 E., S. B. M. about 1½ miles south of the Blue Bell mine and 7 miles west of Baker. Owner: J. A. Alexander, Bakersfield.

The Little Mike mine consists of a single pit from which approximately 40 tons of copper-silver ore were removed, wholly in 1949. The ore body, like those of the nearby Blue Bell mine, occurs in limestone

near an intrusive contact with a granitic mass. The body, now removed, was a pod that probably did not exceed 25 feet in maximum dimension. The ore, according to Roy V. Waughtel, the former lessee, averaged about 5½ percent copper and 3½ ounces of silver per ton.

New American Eagle (American Eagle).[23] Location: sec. 31, T. 3 N., R. 24 E., S. B. M. (projected), near the north-south drainage divide at the west end of the Whipple Mountains and about 11 airline miles northeast of Vidal Junction. Owner: Pete Hulsman, Vidal, California.

The American Eagle mine was first operated in 1908, when a two-compartment 300-foot vertical shaft was sunk, but little ore was produced. In 1912 the property was leased by James S. Douglas who shipped ore from stopes between the 80-foot level and the surface. Subsequent lessees mined and shipped some high grade ore from the 120-foot level and the mine was probably last operated in the period 1918-19. The total production has been about 700 tons which averaged about 8 percent copper.

The ore bodies lie along a strong fracture zone which strikes N. 35° W. and dips steeply to the southwest in a pre-Cambrian metamorphic complex composed principally of mica schist and metarhyolite, the latter forming the footwall of the fracture zone. The schist strikes N. 35° W. and dips steeply to the southwest. The complex is also cut by diabase bodies; a narrow diabase dike follows the hanging wall of the fracture zone. Copper ore was deposited along the zone and along fractures in the metarhyolite footwall. The primary minerals are pyrite and chalcopyrite; the latter is associated with abundant secondary chalcocite.

The fault zone was explored by level workings from the 300-foot shaft at 80, 120 and 180 feet. The ore shoot from which most of the ore was mined extended from the surface near the collar of the shaft to the 120-foot level and reached a maximum length of 50 feet and a maximum width of 20 feet. No chalcocite-bearing shoots of significance were found below the 120-foot level, although chalcopyrite is present in smaller ore bodies on the 180-foot level.

The main shaft is now caved at the surface and was formerly filled with water to the 180-foot level. Through a distance of about 700 feet southwest of the shaft numerous open cuts and shallow pits have been dug. At this point a vertical shaft of undetermined depth is water-filled to about 40 feet below the collar.

New Trail Mine.[24] Location: secs. 9, 16, 21, and 22, T. 15 N., R. 14 E., S.B.M., on the east flank of the Ivanpah Mountains about 6 airline miles southeast of Mountain Pass and about 34 airline miles east of Baker. Ownership: New Trail Mining Company, Mrs. H. I. Kent, president, La Calino Ranch, Riverside, California, owns 14 unpatented claims, all leased to W. H. Hile, 95 Monterey Road, South Pasadena, California.

The New Trail copper-gold-silver mine was worked mostly in the period 1918-19, but has been reopened at intervals since. Exploration work was done as late as 1951.

The ore bodies occur mainly in limestone but within several hundred feet of a contact with a large quartz monzonite body. The limestone beds

[23] Much of the information on this mine has been taken from a private report made in 1918 by Philip D. Wilson.
[24] Most of the data in this section was supplied in personal communication by Mr. W. H. Hile.

strike northwest and dip 20° to 40° SW. They contain irregular tongues of quartz monzonite and irregular bodies of garnet-epidote rock.

The mine workings center around 2 veins about one mile apart. The Colorado workings lie along a fault zone from which a tabular body, containing secondary copper minerals, was removed. The zone is 5 to 30 feet wide, and has been explored laterally by surface workings for about 175 feet, and by moderately extensive underground workings, now caved.

The Anchor workings, nearly a mile northwest, explore a vein that strikes N. 40° E., dips 70° to 85° NW., and is 5 to 30 feet wide. It is exposed laterally for nearly 200 yards. Workings include a shaft, 300 feet deep, with 3 levels. The 100-foot level is open 120 feet northeast and 500 feet southwest of the shaft; the 200-foot level, 30 feet northeast and 570 feet southwest; and the 300-foot level, 550 feet southwest of the shaft. The mine was operated from 1947 to 1950 by W. H. Hile, and in 1950-51 by Alloy Mining Company. Copper-gold-silver ore, valued at about $12,000 was mined in that period. The ore averaged about 7 ounces in silver, 5.73 ounces in gold and 6.2 percent copper. In 1950 and 1951 only development work was done. This included 25 diamond drill holes totaling about 1500 feet, and nearly 800 feet of drifts, raises, winzes, and crosscuts.

Ord Mountain Mine. Location: secs. 13 and 24, T. 7 N., R. 1 E., S. B. M., along the west flank of Ord Mountain and approximately 14 miles southeast of Daggett. Ownership: H. J. Stevenson, 1231 Sunset Plaza Drive, West Hollywood, California, owns eight patented and 20 unpatented claims.

Gold-bearing copper minerals occur in discontinuous veins in the late andesitic Jurassic (?) lavas and metaporphyry of the Ord Mountain group described by Gardner.[25] The veins are irregularly distributed within a shear zone, which strikes northwest and dips steeply north. This zone is traceable for at least 2 miles and is as much as 250 feet wide. In general, it follows the contact between the Ord lavas and metaporphyry on the east and hornblende quartz monzonite on the west. The contact is irregular in detail, and irregular bodies and splinters of either wall rock may be found on either side of the zone, and within the shear zone itself.

The ore bodies are discontinuous; most appear to be shallow and small. Primary ore minerals are chalcopyrite and cupriferous pyrite carrying gold. Azurite and malachite have formed near the surface. Gangue minerals are quartz, barite, and calcite.

The patented claims are, north to south; the Brilliant, Tehachapi, Modesto, Josephine, Last Chance, Coupon, Central, and Rio Vista. The whole deposit can be roughly divided into three groups of ore bodies: the north end, including the Brilliant and Techachapi; the middle, including the Modesto, Josephine, Last Chance, Coupon, Belgium, and Copper Junction; and the south end, including the Central and Rio Vista claims.

The property has been rather extensively developed over a period of forty years or more. In the northerly group, the Brilliant claim has a 200-foot, 70° inclined shaft. Levels at 100 and 180 feet total several hundred feet in length. In 1942 these workings yielded about 80 tons of

[25] Gardner, D. L., Geology of the Newberry and Ord Mountains, San Bernardino County, California: California Div. Mines Rept. 36, pp. 257-292, 1940.

ore averaging between two and three percent copper and $7.75 gold. The Josephine claim has a 500-foot tunnel, a 100-foot shaft, and a 30-foot shaft. Thirty-five tons of ore averaging 2½ percent copper were mined from the latter shaft in 1939.

In the middle group, the Coupon claim has two tunnels with workings totaling 500 feet or more. The Belgium claim has a 400-foot tunnel with a 200-foot winze. The Copper Junction claim has a 200-foot tunnel with a 65-foot cross cut connecting to the Belgium workings.

The principal workings in the south end are on the Rio Vista claim. Three cross cut tunnels, 80 to 100 feet apart vertically have been driven to the east. The lower one is caved. In the vicinity of these tunnels, a cross fault with an east-west strike and a steep northerly dip cuts the main shear zone. The intersection of the fault with the shear zone has localized T-shaped ore bodies between the middle tunnel and the upper tunnel 80 feet above. These ore bodies were stoped in 1942, yielding over 1,000 tons of ore averaging nearly two percent copper and $5.51 in gold. The shear zone also contains numerous other shallower shafts, tunnels, and prospect pits, in addition to these more important workings.

The property was idle in late 1951.

Sagamore (New York) Mine.[26] Location: secs. 33 and 34, T. 14 N., R. 16 E., S. B. M. (projected), on the southeast slope of the New York Mountains, and about 6 airline miles south-southeast of Ivanpah. Ownership: H. B. Hollingsworth and associates, 1496 E. Grand Avenue, Pomono, California, own 7 patented claims.

The Sagamore mine, one of the earliest mining operations in San Bernardino County, was opened in 1870 by Mormon pioneers who, at first, removed silver ores from narrow, high-grade veins in an area about one-quarter mile east of the present camp. The property has since changed hands several times. In the 1890's veins nearby were worked for copper-lead-zinc. With the discovery of tungsten minerals in the ore, the property was reopened in 1914 or 1915.[27] Activity continued until the early 1920's but little ore was shipped. The property was again worked in the period 1942-45 when about 300 tons of ore were shipped. Recently small shipments have been made by the present owners who acquired the property in 1951.

The principal workings lie within an area about three-quarters of a mile long and one-quarter of a mile wide, and covering both sides of an east-trending canyon. The ore bodies are contained in several quartz veins that cut a slightly schistose quartzite, the Tapeats sandstone of Cambrian age.[28] The largest and most westerly vein, the Alpha, is several thousand feet long, 4 to 14 feet wide,[29] trends east-northeast, and dips almost vertically. The ore minerals, principally galena, sphalerite, chalcopyrite, and hubnerite, are most abundant in shoots within the veins.

The older workings, which lie mainly in the eastern part of the mine area, consist of several shafts and adits, now largely caved or water-filled. None of these openings appears to give access to workings more than a

[26] Mr. W. P. Irwin, Geologist, U. S. Geological Survey, has kindly contributed much of the data in this description.
[27] Cloudman, H. C., Huguenin, Emile, Merrill, F. J. H., and Tucker, W. B., San Bernardino County: California Min. Bur. Rept. 15, p. 790, 1919.
[28] Hewett, D. F., personal communication.
[29] Tucker, W. B., and Sampson, R. J., Mineral resources, San Bernardino County: California Div. Mines Rept. 30, p. 437, 1943.

few hundred feet long. The more recent work has been confined to the Alpha vein. The western part of the vein has been penetrated by two drift adits, trending south-southwest, and two vertical shafts. The lower adit, reported by the operators to be 1100 feet long, is caved at 680 feet. The other adit, 45 feet higher, is reported to be 700 feet long, and is caved at 280 feet. One shaft, whose collar is near the portal of the upper adit, has been sunk to the lower adit. The other shaft, about 350 feet to the west, probably is also connected to the lower adit. In 1951 and 1952 the work was intermittent and on a small scale.

Standard No. 2 Group. Location: secs. 19 and 30, T. 15 N., R. 14 E., and secs. 24 and 25, T. 15 N., R. 13 E., S.B.M., in the western foothills of the Ivanpah Mountains, and about 7 airline miles southeast of Mountain Pass. Ownership: R. B. Gill, Cima, California, owns ten claims.

The Standard No. 2 mine, most active in 1917-19 and 1934-35, has a small total output. Copper ore was produced in the first period and lead-copper ore in the second. The property has been further explored in recent years, but has been unproductive.

The deposits lie in the Goodsprings dolomite (Cambrian?) a unit extensively exposed on the west flank of the Ivanpah Mountains. In the mine area, the dolomite strikes northwestward and dips 40° to 60° SW. Mineralization is associated in part with alteration zones near basic dikes in brecciated parts of the limestone.

Workings include over a thousand feet of tunnels and shafts on various claims irregularly disposed along a 1-mile belt. The main Standard No. 2 shaft inclined 80° westward, penetrates the brecciated zone. The shaft is reported [30] to be 275 feet deep, and to have yielded over five thousand dollars worth of copper-gold-silver ore from its 100- and 150-foot levels. One shipment assayed 13 percent copper, 8 dollars in gold, and 16 ounces of silver per ton. Although its headframe is still standing, this shaft has been unused for many years. In a southeasterly line from this shaft, about one-quarter mile apart, are two groups of less extensive workings in similar altered zones in the limestone. In the most recent work, about half a mile west of the shaft, a tunnel was driven 230 feet south through limestone. No production resulted.

Von Trigger (California Gold and Copper, Dutch Oven, Run Over Consolidated) Mine. Location: secs. 2, 10, 11, 15, T. 11 N., R. 17 E., S.B.M., at the south end of Lanfair Valley and about 8½ airline miles northwest of Goffs. Ownership: An estate, for which the following are trustees, L. P. Scaroni, T. A. Twitchell and Guy L. Goodwin, J. F. Goodwin Company, 6363 Wilshire Blvd., Los Angeles, California, owns 9 patented claims.

The Von Trigger mine area was located in 1858, probably for placer gold. It was relocated in 1891 as a copper property by a Mr. A. H. Cram. The first recorded shipment from the property was made in 1907 and totaled 29 tons of ore which assayed 8.87 percent copper.[31] In 1909 a leaching plant was erected and 30,000 tons of ore were piled on the dumps for treatment. In 1913 a 160-ton mill was erected to recover gold from the ore by cyanidation and copper by electrolytic means; but it was unsuccessful, and the mine was inactive until 1926. The principal production

[30] Bembry, J. Riley, personal communication.
[31] Rhodimer, T. A., private report, 1944.

was obtained in the period 1926-1929, when the property was worked by the California Gold and Copper Company; shipments totaled 77 cars or 3729 tons of ore averaging 5.03 percent copper.[32] In 1941 an attempt to precipitate cement copper, by the use of tin cans, was unsuccessful. The most recent operation was during 1944-45 when the property was leased by the Dutch Oven Mining Company, Homer C. Mills, president. A few shipments were made, totaling about 1175 tons; the average copper content was less than 3 percent.

The copper minerals occur discontinuously along slightly brecciated zones in Archean gneiss and schist. The brecciated zones trend northeast, apparently parallel with the planar structure of the schist and gneiss. Oxidized copper minerals, principally malachite, are found to depths of 100 to 140 feet; the primary copper mineral below this oxidized zone is principally chalcopyrite.

The two principal deposits have been explored by inclined shafts ranging in vertical depths from 30 to 300 feet. The Medburry shaft, from which most of the ore has been shipped, was sunk on a 55° incline to an inclined depth of 280 feet, with level workings at vertical depths of 65, 110 and 200 feet. Water stands in the shaft at 110 feet. Most of the ore from this shaft was stoped above the 100-foot level and southwest of the shaft. Surface indications on this orebody show a width of 20 to 110 feet and a length of 400 feet.

The Goodwin shaft, 500 feet to the east, was sunk to a vertical depth of 300 feet with levels at 72, 100 and 300 feet. Water now stands at 100 feet. To the northeast two other shafts were sunk on the same orebody; the Twitchel shaft, with a vertical depth of 96 feet, and the Scaroni shaft, with a vertical depth of 30 feet. Surface exposures indicate an orebody 600 feet long and ranging in width from 20 feet at the Goodwin shaft to 250 feet at the Scaroni or Hummingbird shaft about 600 feet northeast of the Goodwin. These 3 shafts apparently predated the Medburry shaft around which most of the recent work has centered. Smaller orebodies are explored by shallow pits and open cuts.

Gold

Gold is the most widely distributed metal of commercial value in San Bernardino County. Gold-bearing deposits are scattered throughout the county, from the Slate Range in the northwest section to the Whipple Mountains in the southeast corner, and from the slopes of the San Gabriel and San Bernardino Mountains in the southwest to the Clark Mountain area in the northeast. Gold was the predominant metal in 27 of the 45 mining districts in the county as listed by Hill.[33] At least nine others contained deposits in which gold was present in important quantities. From 1880 to 1950 the gold mined in the county had total recorded value of $12,148,353.

Most of the gold-bearing veins cluster around bodies of Mesozoic granitic rocks, either in adjacent metamorphic rocks or in the intrusive rocks themselves. There are many exceptions, however.

Most of the gold-bearing deposits have been worked to relatively shallow depths, although lateral workings in many properties are extensive. The Supply mine, which, together with the Nightingale, had the largest

[32] Goodwin, Guy L., personal communication, 1952.
[33] Hill, James M., The mining districts of the western United States: U. S. Geol. Surv. Bull. 507, pp. 126-130, 1912.

production in the Dale district, was probably explored to the greatest depth; its main shaft extends 1,250 feet on a 70° inclination to a vertical depth of about 1,185 feet.

The formal recording of gold production began in 1880, but some of the placer mining areas, such as Bear Valley and Holcomb Valley, were being operated in the 1850's [34] and some of the lode deposits probably were operated shortly thereafter. As with all mining, the changes in economic conditions and changes in accessibility of the deposits have influenced the degree of activity in the gold districts. Several properties which had been successfully operated prior to being closed down in 1942, when the War Production Board issued its Limitation Order L-208, have been unable to meet the cost of reopening, plus the current high operating costs. Only one property, the Bagdad Chase, was allowed to operate during the time of L-208, and that because the copper-gold ore is highly siliceous, a type of ore essential in copper smelting. This one mine has yielded about half the county's total recorded gold output.

Alvord Mine. Location: secs. 1, 2, and 12, T. 11 N., R. 3 E., S.B.M., in the southern part of the Alvord Mountains, about 6 miles north of Manix and 16 miles northeast of Yermo. Ownership: Dell'Osso Gold Mining Company, P. O. Box 3435, Terminal Annex, Los Angeles, California, owns 24 claims, of which 6 are patented.

The Alvord gold deposits were located in 1885 and operated until 1891 by the Carter Gold Mining Company. The ore was treated in a 5-stamp mill at Camp Cady on the Mojave River, an operation that produced a total of $50,000.[35] The property was also active during the periods 1906-1910 and 1916-1920. The Dell'Osso Mining Company has held the property since 1925. The mine was most recently operated by Roy Waughtel, Manix, California, from June 1950 to early 1952.

The gold occurs in a siliceous vein within crystalline limestone, and close to a contact with granitic rock. The vein contains abundant jasper and limonitic material.

Development consists of an old glory hole about 150 feet in diameter and 2 adits, driven eastward below it at 100-foot intervals, 500 and 550 feet in length. One hundred feet from the portal of the lower adit, a crosscut has been driven 100 feet south along the limestone-granitic rock contact. Most of the earlier production came from the upper adit. Waughtel's work was confined to the lower adit. The ore obtained in these operations was treated in a mill on the property utilizing a 6-stamp crushing unit, amalgamation and cyanidation.

America (American) Mine. Location: secs. 18, 19, T. 4 N., R. 12 E., S.B.M., on the northern slope of the Sheep Hole Mountains, and about 9 airline miles south of Amboy. Ownership: Clara C. Engelke and others, care of Walter Alf, P. O. Box 36, Daggett, California, own 9 claims.

The America claims were first located in 1903. Four of the claims, America, America No. 1, 6 and 7 were patented in 1925 and 1926. The last serious effort to operate the property was made from 1936 to 1940 by the American Mines, Incorporated of Los Angeles. Production from the property is not known to the writers but is probably small.

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[34] Hewett, D. F., and others, Mineral resources of the region around Boulder Dam: U. S. Geol. Surv. Bull. 871, pp. 45-54, 1936.

[35] Tucker, W. B., and Sampson, R. J., Mineral Resources of San Bernardino County: California Div. Mines Rept. 39, p. 439, 1943.

Free gold associated with quartz, hematite and lesser amounts of arsenopyrite and chalcopyrite occurs in veins and seams in alaskite. The principal vein strikes east and dips 25° to 40° N. This vein is cut off at a depth of about 55 feet by a trachyte dike that followed a nearly-horizontal fault zone.[36] A diorite body lies north of the mine workings.

Development work consists of two crosscut adits with appended drifts, two vertical shafts, each intersected by these adit workings, and several open cuts and shallow shafts. The portal of the upper adit, which was driven S. 20° W., is about 150 feet southwest of the portal of the lower adit that was driven S. 30° E. Length of underground workings probably totals more than 2000 feet.

A 50-ton sand-leaching cyanide mill was erected on the property but apparently operated only briefly. A foundation for a larger mill, which was never installed, remains on the property.

Bagdad Chase (Pacific Mines) Mine. Location: secs. 7, 8, T. 6 N., R. 8 E., S.B.M., 7 miles south of Ludlow at the old town of Stedman. Ownership: Bagdad-Chase Mining Company, George Manierre, president, 3851 Santa Fe Avenue, Los Angeles, California, owns 30 patented claims; the property is leased to Don L. Love, Box B, Ludlow, California.

The Bagdad Chase mine, the principal single source of gold and copper in San Bernardino County, since 1904 has yielded more than 6 million dollars worth of gold, or over half of the total recorded gold production of the county since 1880. From 1904 to 1910 the mine was operated by the Bagdad-Chase Mining Company, which treated 150,000 tons of ore at its mill in Barstow, using the cyanide process and recovering gold only. The total value of gold recovered was $4,500,000.[37] During the following 6 years, when the mine was operated by the Pacific Mines Corporation, 120,000 tons of copper-gold ore was shipped to a smelter at Clarkdale, Arizona. This output had an average grade of 1.82 percent copper, 0.35 ounces of gold and 1.5 ounces of silver per ton. The d'Aix Syndicate, operating for 12 months during 1938-39, produced 850 tons of ore averaging $9.80 per ton in gold. The Bagdad Chase has been operated almost continuously since 1940 by lessees; the present operator has been on the property since 1943.

As a point of historical interest, the town of Stedman (or Steadman) was once named Rochester. The mines in that district, including the Bagdad Chase, were served by a railroad, known as the Ludlow and Southern, which ran 7½ miles from Ludlow to Rochester. It was constructed between 1899 and 1901 and operated until the mid-1920's.[38]

The ore occurs in a fault breccia zone between a quartz monzonite footwall and a rhyolite hanging wall. The breccia contains fragments of both of these rocks in a siliceous matrix which carries gold and oxidized copper minerals, principally chrysocolla. The mineralized breccia zone strikes east, dips gently north, ranges in width from 8 to 20 feet, and is several hundred feet long. North-striking faults have displaced the zone as much as 240 feet.

The deposit has been mined from 3 principal shafts, in triangular arrangement and a few hundred feet apart. Workings from the 90-foot

[36] Davis, W. Buford, private report, 1940.
[37] Tucker, W. B., and Sampson, R. J., Economic mineral deposits of the Newberry and Ord Mountains, San Bernardino County: California Div. Mines Rept. 36, p. 232, 1940.
[38] Barlow, Earl W., personal communication.

level of the easternmost of these, a vertical shaft 125 feet deep, extend upward into a glory hole just east of the shaft. An ore body in this area was mined from 1940-47 and yielded about 65,000 tons of ore. During 1947-48, a small tonnage of ore was mined from the 200-foot level of a 400-foot vertical shaft located west of the 125-foot shaft. Southwest of the 125-foot shaft, a shaft inclined 40° N. 70° W. has been sunk to a depth of 450 feet. Operations from 1949 through 1951 were centered on the 400-foot level in this shaft, yielding an estimated 8000 to 9000 tons of ore.

Because the ore is siliceous and highly desired by smelters, the producer is given preferential treatment charges. Also, the mine was able to operate during World War II when the War Production Board's Limitation order L-208 had shut down most other gold-producing mines. Shipments are made to the Hayden, Arizona or Selby, California smelters of the American Smelting and Refining Company.

Black Hawk Mine. Location: sec. 7, T. 30 S., R. 41 E., M.D.M., 2½ miles southeast of Randsburg. Owner: George H. Clapp, Sewickley, Pennsylvania (1949).

The Black Hawk mine, generally and erroneously described as being in Kern County, operated almost continuously from 1896 to 1942. It has yielded about $700,000 in free milling gold obtained from ore assaying between $12 and $60 per ton.[39]

The mine has developed three quartz veins that cut the Rand schist. For most of their lengths the veins range from 18 inches to 3½ feet wide. They strike northward and dip about 50° eastward. The principal workings consist of a 600-foot inclined shaft with levels at 100, 200, 250, 450, and 600 feet. Level workings total nearly 7500 feet in length. Included on the 8 claims that comprise the property are the Pittsburg and Mt. Shasta and the Garford Lease workings noted in the silver section of the accompanying tabulated list. These were driven in an unsuccessful search for extensions of the zone of silver mineralization of the nearby Kelly mine.

The gold ore was treated in a 5-stamp amalgamation mill on the property. The mine was closed by Federal wartime restrictions in 1942.

Brannigan Mine. Location: secs. 26 and 27, T. 13 N., R. 10 E., S.B.M. (projected), on west slope of northern extension of Old Dad Mountain, and about 13 airline miles southeast of Baker. Owner: Walter Thompson and associates, 1010 Cadberry Road, Whittier, California.

Although claims in the Brannigan mine area were located as early as 1905, ore shipments were confined to the period 1928-1935 when the mine was most actively worked. It has yielded several thousand tons of gold ore, carloads of which are said to have averaged as much as $110 per ton.

The ore bodies occur along fracture zones in quartzite of probable pre-Cambrian age. Most of the gold is in discontinuous quartz veins generally from 3 to 6 feet thick. Some appears to have been mined from thin, bedding-plane seams.

Two zones about a quarter of a mile apart contain most of the mine workings. The more westerly, or Number 1, workings follow a zone that

[39] Tucker, W. B., Sampson, R. J., and Oakeshott, G. B., Mineral resources of Kern County: California Jour. Mines and Geology, vol. 45, p. 214, 1949.

strikes about N. 35° E. and dips steeply northwestward. Several northeast-trending drift adits have penetrated a segment of the zone no more than 200 feet in maximum dimension. The Number 2 workings consist of three adit levels, driven southeastward within a vertical distance of about 70 feet, that explore a fracture zone that trends northwestward and dips moderately southwest. Most of the ore recovered from this zone has been obtained from winzes and stopes of the upper and middle levels which are about 200 and 50 feet long respectively. The lower level, about 300 feet long, appears to be in barren quartzite. Also on the Brannigan property are several pits from which a small tonnage of variegated lavender, orange and red, fine-grained sandstone has been mined as ornamental stone.

Brooklyn (part of Brooklyn and Los Angeles) Mine. Location:[40] sec. 36, T. 1 S., R. 12 E., S.B.M. (projected), in the southeastern part of the Dale district east of Twentynine Palms. Owner (1930): Campbell Gold Lease Company, San Bernardino, California.

The gold-bearing vein, developed by the Brooklyn mine, was discovered in 1893, and worked by the Brooklyn Mining Company from 1901 to 1916. Apparently only intermittent operations were carried on until the 1930's when this and the adjoining Los Angeles mine were in operation. The total production of the Brooklyn mine is reported to have been $150,000 prior to 1930.[41] The output of the Brooklyn mine during the 1930's is not recorded separately, but the total of both for this period was over $13,000. Much of this, however, came from the Los Angeles.

In the area of the two mines, five parallel quartz veins cut granodiorite, strike northwestward, and dip 70° SE.; the veins are spaced about 1000 feet apart. The principal mine workings lie along the two main veins, the Brooklyn and Los Angeles.

The Brooklyn vein ranges in width from 2 to 4 feet and is 4500 feet in exposed length. Free gold occurs associated with iron oxides and oxidized copper minerals. Some of the ore developed had a value of $16 per ton in gold and contained 1 to 3 ounces of silver per ton.

The Brooklyn mine workings consist of a 550-foot drift adit, driven northwest about 100 feet below the outcrop, from which a 200-foot winze was sunk on the vein at a point 300 feet from the adit portal. Level workings from this winze at 60(?), 110, 160 and 200 feet below the adit level developed two ore shoots which were mined; one was 100 feet long, the other 200 feet, and both had an average width of 4 feet.

A mill on the property included three 750-pound stamps and a 30-ton rod mill. In recent years the mine has been idle.

Carlyle Mine. Location: sec. 11, T. 1 S., R. 12 E., S.B.M., on the northeast slope of the Dale portion of the Pinto Mountains about 23 miles southeast of Twentynine Palms. Ownership: Mrs. Shaeffer, Pomona, California, owns 8 claims, of which 4 are patented.

The Carlyle mine was opened in the early 1900's, but little is known of its first operations. In 1915 the mine was known as the Carlisle.[42]

[40] The Brooklyn and Los Angeles mines have been reported both in San Bernardino and Riverside Counties. Only the Brooklyn is thought by the writers to be in San Bernardino County.

[41] Tucker, W. B., and Sampson, R. J., San Bernardino County: Califorina Div. Mines Rept. 26, p. 229, 1930.

[42] Cloudman, H. C., Huguenin, Emile, and Merrill, F. J. H., San Bernardino County: California Min. Bur. Rept. 15, pp. 802, 803, 1919.

Apparently its most active period was between June 1936 and March 1939 when the mine was operated by the Carlyle Mining Corporation which produced $124,000 worth of gold, silver and lead from 13,256 tons of ore. During the period 1939-1940, some ore was produced by the Camco Mining Company (R. M. Campbell, Twentynine Palms), a lessee. The mine was last operated by another lessee in 1941.

Finely divided gold is associated with silver and lead minerals in a vein along a fault in granitic rock. The vein strikes N. 15° E., dips 75° W. and ranges in width from 6 to 12 feet. The silver minerals are pyrargyrite, polybasite and stephanite. The lead minerals are galena, cerussite and anglesite.

In a 1200-foot adit, driven south along the vein, five ore shoots were encountered. The first shoot, 100 feet long and 6 feet in average thickness, was found 600 feet from the adit portal, and was stoped to the surface, a maximum height of 200 feet. Raises also were driven to the surface at 480 and 580 feet from the adit portal. A winze, sunk 680 feet from the portal, has a 200- and a 250-foot drift at the 30- and 80-foot levels respectively. These winze workings developed an ore shoot 60 feet long and 6 feet wide, reported to average $12 per ton in gold; the gold values were principally on the hanging wall, and high grade silver ore was reported on the footwall.[43]

A mill on the property, erected some time after 1915, recovered the values in gold, silver and lead by means of a jig, flotation cells and a concentrating table. Mill heads were reported to carry $10 to $20 per ton in gold and $3 to $6 per ton in silver.[44]

Doble (Gold Mountain, Lucky Baldwin) Mine. Location: secs. 25 and 36, T. 3 N., R. 1 E., S.B.M., on northeast ridge of Gold Mountain, overlooking Baldwin Lake. Ownership: James Hulmes estate, South Pasadena, California, owns 8 patented claims and 8 unpatented claims.

The Doble mine was most actively worked in the late 1800's, when it was owned and operated by E. J. "Lucky" Baldwin. Since 1900 the mine has been reopened for relatively short periods by several lessees. The mine was most recently leased shortly after the end of World War II; a mill was installed and a small tonnage mined. Late in 1951, however, all equipment had been removed and the property was idle. The output since 1900 had a value estimated at between $250,000 and $300,000.

The claim containing the most extensive workings lies athwart a west-northwest-trending fault contact between the massive Paleozoic Saragossa quartzite (Mississippian?) on the south and a soft schist on the north. Both formations dip moderately southward; the fault separating them dips gently in the same direction. The workings, which now exist as an open cut about 600 feet long, lie along the contact for most of their length but extend westward into the quartzite. The mineralized zone averages about 40 feet wide, but has been largely removed or is hidden beneath debris. The zone consisted of a system of irregular quartz veins in the quartzite and contained the strongest mineralization along northeast-trending cross-fractures. When operated in the late 1930's, the ore is believed to have averaged $6 per ton.[45] In a tunnel driven for the length

[43] Tucker, W. B., and Sampson, R. J., op. cit., p. 444, 1943.
[44] Tucker, W. B., and Sampson, R. J., idem, p. 445.
[45] Tucker, W. B., and Sampson, R. J., Current mining activity in southern California: California Div. Mines Rept. 36, pp. 66-67, 1940.

of the zone and a few tens of feet beneath the surface, the fault was found to have cut off the gold-bearing rock at a shallow depth.

Keystone Mine. Location: sec. 18, T. 7 N., R. 2 W., S.B.M., on the south slope of Stoddard Mountain, about 18 miles northeast of Victorville. Ownership: James W. Graef, Los Angeles, California, and John Vader, Eagle Rock, California, own two claims.

The Keystone gold deposits were discovered prior to 1900; the owners estimate that the deposits have yielded a total output to date valued at about $180,000. The property was last operated in 1947, but no shipments were made then.

The mine area contains several gold- and silver-bearing quartz veins in rhyolite which underlies the south part of Stoddard Mountain. The quartz veins are vuggy and stained with limonite. They range in thickness from less than 3 inches to about one foot, strike northward, and dip steeply east and west. Small faults evidenced by slickensides and thin gauge zones parallel the veins, and often follow along one or both walls of a vein. The gold occurs as fine flour gold, bearing some silver. Assays as high as $800 are reported, but most of the ore is said to have run about $50 per ton.

The mine has fairly extensive workings. It is developed by about seven adits on three levels. Raises connect the level workings. The lowest crosscut adit was driven about 100 feet N. 50° W. and has some drifting from it. Two other adits, at 50-foot intervals, explore the deposit for about 150 feet into the mountain. Numerous prospect pits and trenches also have been dug on vein outcrops.

Mollusk (Mescal, Cambria) Mine. Location: sec. 24, T. 16 N., R. 13 E., S.B.M. (projected), near Mescal Spring in the Mescal Range, about 1½ airline miles southeast of Mountain Pass and about 33 airline miles east of Baker. Ownership: Dr. Nowland MacFarlane, 5217 South Main Street, Los Angeles 37, California, owns one patented claim and a millsite.

The Mollusk mine is a high-grade gold-silver mine with a reported total production of about $250,000.[45a] It was first operated from 1882 to 1888, and has since been active only for a brief period in 1915.

The ore was mined from a quartz vein from several inches to 3 feet wide, and following a bedding plane in dolomitic limestone. The vein strikes north-northwest, and dips 30° W. into the hillslope. The vein is several hundred yards in exposed length.

Workings consist of large open stopes between 3 drifts spaced about 50 feet apart. A main haulageway has been driven 50 feet beneath the lowest drift level. The workings were joined to a road by a 350-yard rail tram. All equipment has been removed.

A half mile away, at Mescal Spring, is the site of the 10-stamp mill, built in 1886. The water rights to the spring have been leased to Molybdenum Corporation of America to provide water for the Mountain Pass mill several miles to the north.

New Era Mine. Location: sec. 20 (?), T. 15 N., R. 14 E., S.B.M., about 7 airline miles southeast of Mountain Pass and about 33 airline miles east of Baker, just west of the crest of the Ivanpah Mountains. Ownership: Ross Gill, Cima, California, owns two unpatented claims.

[45a] Dr. Nowland MacFarlane, personal communication.

The New Era is a small gold mine in which high grade zones are said to have yielded $14,000 in gold prior to 1914. A mill, formerly on the property, has since been removed and the mine has been idle except for assessment work.

Quartz monzonite, part of the mass that forms the core of the Ivanpah Mountains, underlies the mine area. The gold occurs in a stockwork of narrow quartz veins that fill parallel fractures in the granite. The veins strike north and dip steeply eastward.

The workings consist of a single shaft inclined 80° east, and following the dip of the quartz vein system. The shaft is reported to be 150 feet deep with levels at 50, 80, and 150 feet. Level workings total several hundred feet. Minor surface trenching on the hill crest exposes barren quartz veins dipping 25° east.

Olympus (Paradise) Mine. Location: sec. 18, T. 12 N., R. 1 E., S.B.M., on the south slope of the Paradise Mountains, and about 2½ miles south of Paradise Spring. Owner (1930): Olympus Gold Mining Company, 508 Alvarado, Redlands, California.

The Olympus is a small gold mine the development and operation of which was confined largely or wholly to two periods, 1915-1925, and 1935-1941. The total production from the mine is small. The mine area is underlain by part of a large body of granitic rock, probably Mesozoic in age, that forms much of the western part of the Paradise Range. The granite is cut by several gold-bearing quartz veins which strike northwest and dip 30° to 40° northeast. They range from one-half foot to 20 feet wide, and probably do not exceed 500 feet in length. The quartz is vuggy and heavily stained with iron oxides and manganese oxides. The gold as mined is reported to have been free-milling and to have averaged about $6 per ton.[46]

The principal workings, confined to a single vein, consist of a 400-foot inclined shaft appended to a total of several hundred feet of drifts and cross-cuts driven from levels at 135, 235, and 400 feet. On this vein, the Klondike, are two northwest-trending drift adits separated by a vertical distance of about 50 feet. The lower adit, whose portal is near the shaft collar, is about 400 feet long. The higher adit is about 300 feet long. The other veins in the mine area have been prospected by cuts and shallow shafts. Also on the property are the remnants of a 10-ton stamp mill.

Oro Fino Mine. Location: secs. 23 and 26, T. 13 N., R. 10 E., S.B.M. (projected), on west slope of northern extension of Old Dad Mountain, and about 13 airline miles southeast of Baker. Ownership: Jerry Korfist and associates, Baker, California, own 4 claims.

The area of the Oro Fino gold mine is thought by its owners to have been first prospected in the 1890's but ore was shipped only during the period 1930-1945 when the mine was rather intensively worked. The ore bodies explored to date occur in an east-trending belt, about 1200 feet long. They lie along faulted and fractured zones that are now discontinuous, but which may represent offset segments of a single zone. The principal rocks of the mine area, probably pre-Cambrian in age,

[46] Tucker, W. B., Los Angeles field division, San Bernardino County: California Min. Bur. Rept. 17, p. 350, 1920.
Tucker, W. B., Los Angeles field division, San Bernardino County: California Min. Bur. Rept. 20, p. 48, 1924.

consist of quartzite in the west part and mica schist and dolomite in the east part. They are cut by basic dikes.

Most of the shipping ore was encountered in siliceous shoots 4 to 6½ feet wide and lenticular in shape. These are reported to contain free gold and auriferous pyrite.[47] They are commonly bordered on one side by a gouge that appears to consist mostly of pulverized dike material. In the central part of the mine area the ore bodies strike westward; in the west and east parts they strike northeastward. Dips are gentle to moderate north and northwest.

The workings exist in three main groups, the West, Middle, and Extension (east). Together they comprise about 2500 feet of shafts and tunnels, none of which are more than 100 feet below the surface. In 1943 the mine was said to have had a total output of about $50,000 in gold.[48]

Osborne Mine. Location: sec. 33, T. 3 N., R. 1 E., S.B.M., in northeast part of Holcomb Valley, Big Bear Lake area. Ownership: W. A. Franklin estate, Los Angeles, California, owns three patented claims.

The Osborne mine, worked for gold in the late 1800's, has been idle for more than 50 years. The three claims are noncontiguous and en-echelon. These are underlain by quartz monzonite containing west-northwest-trending veins. The most extensively worked vein, which is on the middle claim, is poorly exposed but is reported by F. M. Reeves, a nearby resident, to be at least 500 feet long, to dip moderately to steeply northward, and to contain a one to 4-foot width of gold-bearing quartz for most of its length.

The vein has been opened by a shaft, inclined northward at about 40°. It is partly caved and water-filled, but is stated by Reeves to be about 240 feet deep. Workings to the west of the shaft are believed to be largely above the 60-foot level and to extend only a short distance beyond a holed-through raise about 150 feet from the main shaft. Most of the workings lie within 300 feet east of the shaft, beneath an area now overlain by dump material.

A second vein, as close as 100 feet north of the main shaft, has been worked along its strike for about 400 feet, but to much shallower depths.

Ozier Mine. Location: sec. 20, T. 3 N., R. 1 E., S.B.M., on John Bull Flat north of upper Holcomb Valley in Big Bear Lake area. Ownership: August Voght and Walter Alf, Daggett, California, own two patented claims.

The Ozier gold mine, inactive for about 50 years, probably contains the most extensive lode workings in the Holcomb Valley area. The mine was opened by Mexicans, probably in the late 1850's. It is reported to have been most active in the period 1860-90. The mine's output, though unknown to the writers, is believed significant. The claims were patented in 1874. The location of the workings is now shown only by abundant and widespread dump material. The remains of two arrastres are nearby.

The mine area is underlain by a hard to thoroughly decomposed quartz monzonite. Mr. F. M. Reeves, long a resident of the area, reports that the mine consisted of numerous adits and shallow shafts, none more than 100 feet deep. The workings followed a group of steeply dipping

[47] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, p. 457, 1943.
[48] Tucker, W. B., Sampson, R. J., op. cit.

west-northwest-trending fractures closely spaced though a zone 200 feet wide. The fractured and decomposed nature of the quartz monzonite led to the caving of the workings. The gold-bearing rock seems to have been highly hematitic and to have contained little quartz vein material.

Pacific Coast Mill and Mining Company (Barstow Metals Extraction Company). Location: sec. 1, T. 9 N., R. 2 W., S.B.M. Ownership: Hoffman estate, care of Herbert H. Hoffman, 11686 Dornfield Avenue, San Fernando, California, leased to the Pacific Coast Mill and Mining Company, Clarence E. Morris, president, 1020 Highland Avenue, National City, California.

The Bagdad-Chase Mining Company operated a mill on this site from 1904 to 1910 and treated between 100,000 and 150,000 tons of ore from the Bagdad Chase Mine located south of Ludlow. The mill tailings, totaling about 75,000 tons, are reported by the present operators to assay as high as 0.7 percent copper, 0.14 ounce of gold and from 1 to 1.5 ounces of silver per ton.

Efforts had been made to recover the gold by cyanidation but the presence of copper carbonates and silicates caused excessive cyanide consumption. The Barstow Metals Extraction Company leased the property in the early 1930's and built a mill to treat the tailings by acid leaching for copper recovery, followed by cyanidation to recover the gold.[49] Faulty construction in the acid circuit caused mechanical failures and this plant failed to operate.

The present lessees, starting early in 1951, installed a flotation plant, utilizing a 5- by 22-foot ball mill fitted with internal grate dividers, and 9 rougher flotation cells followed by three cleaner cells. The tailings are ground to 100 percent minus 100-mesh and 50 percent minus 200-mesh. As of December 1951, about 75 tons of concentrates had been shipped to Utah; the concentrates average 10 percent copper, 2.6-2.8 ounces of gold and 20 ounces of silver per ton.

Paymaster (Whitney) Mine. Location: secs. 22 and 23, T. 13 N., R. 10 E., S.B.M., in the northwest end of Old Dad Mountain, about 11 airline miles southeast of Baker. Ownership: Lawrence Z. Bess, 890 Campus Way, San Bernardino, California, Walter Thompson and associates, 1010 Cadberry Road, Whittier, California, own 5 unpatented claims, all under lease to Jess and John F. Herrod, 222 South Walnut, Brea, California.

The Paymaster mine has yielded from \$50,000 to \$100,000 in gold since it was opened in 1900. Ore has been removed from a series of quartz veins in a complex of igneous and metamorphic rocks, including granite, gneiss, and schist. Most of the mine workings lie along 3 veins from 200 to 300 feet apart. In general, the veins are 2 to 4 feet wide and several hundred feet long. They strike northeastward and dip 40° to 50° NW. In their mineralized parts, they contain pyrite, magnetite, chalcopyrite, and marcasite.

The main workings consist of a crosscut adit, driven S. 35° E. about 950 feet, from which extend several hundred feet of drifts. The crosscut encounters the Sidewinder vein at 420 feet and the Paymaster vein at 748 feet from the portal. The Sidewinder vein has been followed northeastward by an 85-foot drift, but no ore was mined. A drift follows the

[49] Tucker, W. B., Current mining activity in southern California: California Div. Mines Rept. 30, p. 323, 1934.

Paymaster vein for 240 feet southwest. Here ore has been stoped to the surface, a slope distance of 275 feet. To the northeast the vein has been followed by a 465-foot drift also appended to stopes. At adit level the vein is from 2 to 4 feet wide. Most of the ore has been obtained from this vein. Underground workings total about 2000 feet.

Surface workings have exposed the Discovery vein for about 700 feet along strike, and about $20,000 in gold is reported to have been produced from a series of inclined shafts and stopes, the deepest being 150 feet. Present work started early in 1952 and consists of extending the main adit, now about 200 feet past the Paymaster vein, in an attempt to cut the Discovery vein. This vein is expected to be encountered about 300 feet below its outcrop elevation in the next 50 feet of tunneling on the main adit. Three men were working in April 1952.

Rio Hondo Mine. Location: sec. 12, T. 13 N., R. 1 E., S.B.M., 28 air-line miles northeast of Barstow. Ownership: V. W. Jay and R. H. Chapin, Barstow, California, and Bernice G. Bailey, Portland, Oregon, own 6 claims.

The Rio Hondo is a small gold mine that has been inactive for many years. The mine workings lie along several small, discontinuous quartz veins cutting complexly folded metasedimentary units, principally limestone and schist. The lower part of the hillside, on which the veins are exposed, is underlain by granitic rock which intrudes the metasediments.

The principal workings explore a vein that is several hundred feet long and mostly 2 to 5 feet wide. Much of the vein is said to assay $7 to $15 per ton in gold which is partly free and partly in auriferous pyrite. The workings include two shafts, 72 and 90 feet deep and 50 feet apart, and 2 short adits. The remnants of an amalgamation mill remain on the property.

Rose Mine. Location: secs. 19, 20, T. 2 N., R. 3 E., S.B.M., in northeastern San Bernardino Mountains, and about seven airline miles east-southeast of Baldwin Lake. Owner (1937): Dell Swarthout, San Bernardino, California.

Gold deposits in the vicinity of the Rose mine are said to have been opened by Mexicans perhaps as early as the time of Spanish rule.[50] The mine was worked by Americans, beginning probably in the 1860's, and was most active in the period 1895-1903. It has yielded gold, silver, and a very small amount of copper, with an estimated total value of $450,000 to $600,000.

The Rose mine and the adjacent Christie workings lie along a single mineralized zone in the Furnace limestone (Mississippian?).[51] The zone strikes about N. 20° W., dips moderately northeast, and is at least 2,000 feet long. The zone, although now poorly exposed, appears to exceed 20 feet in width persistently, is heavily iron-stained, and contains granitic dikes and discontinuous bodies of mica schist. The gold is said to occur in a quartz-calcite gangue associated with much hematite;[52] some shipments are reported to have been valued at $200 to $500 per ton.[53] Copper ore was sorted and shipped in small quantities.[54]

[50] Vaughan, F. E., Geology of San Bernardino Mountains north of San Gorgonio Pass: California Univ., Pub. Dept. Geol. Sci., Bull. vol. 13, no. 9, p. 410, 1922.
[51] Vaughan, F. E., op. cit., p. 410.
[52] Crawford, J. J., California Min. Bur. Rept. 12, pp. 234-235, 1894.
[53] Tucker, W. B., and Sampson, R. J., Los Angeles field division; San Bernardino County: California Div. Mines Rept. 26, p. 250, 1930.
[54] Aubury, L. E., The copper resources of California: California Min. Bur. Bull. 50, p. 334, 1908.

The principal workings center about two shafts approximately 850 feet apart. The more southerly shaft is steeply inclined and now caved close to the collar. It is said to be 450 feet deep.[55] The other shaft is vertical and of about the same depth. These are joined to several thousand feet of level workings.

Santa Fe Mines (Includes workings known variously as Arlington, Black Hawk, Calle de Oro, Calumet, Cliff, Hecla, Lady Alice, Lookout, and Opera). Location: secs. 5, 8, 9, 16, 17, T. 3 N., R. 2 E., S.B.M., on northeastern slope of San Bernardino Mountains, and 5 airline miles north of Baldwin Lake. Ownership: James Hay estate, Los Angeles, California, owns 175 claims.

Gold deposits, in the area which now includes the workings known collectively as the Santa Fe mines, were first located in 1887, and were developed soon afterward by the Black Hawk Company, financed by English capital.[56] This company operated briefly, driving several short tunnels and constructing a 10-stamp mill which operated on steam power and wood fuel. High operating costs forced suspension of operations[57] and the property was idle until 1921 when it was reopened by the Arlington Mining Corporation. It was in nearly continuous operation from 1921 to 1940, and has yielded ore reported to total $300,000 in value.[58] Most of this output was recovered in a 25-ton ball mill and cyanide plant in the bottom of Blackhawk Canyon. A 600-ton cyanide leaching plant was installed in the late 1930's and was dismantled in 1940.

The main gold-bearing zone, known as the Arlington-Santa Fe lode, lies along a thrust fault which strikes westward and dips gently southward. It is exposed, with a nearly horizontal trace, for a distance of about 1¼ miles at the head of Blackhawk Canyon. This fault, named the Santa Fe thrust by Woodford and Harriss,[59] has brought Furnace (Mississippian?) limestone upon granitic rock.

The richest ore occurs as streaks of hematitic gouge distributed through a crushed zone at least 100 feet thick.[60] The zone has been explored by open cuts totaling several hundred feet long, and by at least 9 tunnels 2500 to 3000 feet in combined length. Another gold-bearing zone occurs in a limestone breccia, probably Pleistocene landslide material, exposed along the upper part of the west wall of Blackhawk Canyon. This zone, which is about 75 feet thick, has been developed by workings consisting of more than 1200 feet of tunnels and raises and is known as the Cliff mine.

Although a few relatively small bodies were found to average more than $30 per ton, the known reserves, measurable in millions of tons, are said to be valued in the range of $1.20 to $11 per ton.[61]

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[55] Tucker, W. B., and Sampson, R. J., op. cit.
[56] De Groot, Henry, San Bernardino County—its mountains, plains and valleys: California Min. Bur. Rept. 10, p. 523, 1890.
[57] Cloudman, H. C., Huguenin, Emile, Merrill, F. J. H., and Tucker, W. B., San Bernardino County: California Min. Bur. Rept. 15, p. 798, 1919.
[58] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, p. 461, 1943.
[59] Woodford, A. O., and Harriss, T. F., Geology of Blackhawk Canyon, San Bernardino Mountains, California: California Univ., Dept. Geol. Sci. Bull., vol. 17, pp. 265-304, 1928.
[60] Tucker, W. B., and Sampson, R. J., op. cit., p. 460.
[61] Tucker, W. B., and Sampson, R. J., Los Angeles field division; San Bernardino County: California Div. Mines Rept. 26, p. 224, 1930.

Sidewinder Mine. Location: secs. 4 and 5, T. 6 N., R. 2 W., S.B.M., on the northwest slope of Sidewinder Mountain, and about 13 airline miles northeast of Victorville. Ownership: E. M. Nixon, 204 South San Juan Street, Loma Linda, California, and E. W. Tucker, 3985 Walnut Street, Riverside, California, own three patented claims.

The Sidewinder mine was opened in the 1880's and was worked intermittently until 1942 when closed under the War Production Board Limitation Order L-208. The mine is the largest gold operation in the Barstow-Victorville area.

Most of the workings lie along a single siliceous vein in a fault which, in general, separates rhyolite and dacite on the southwest from quartz monzonite porphyry on the northeast. The former are part of the Sidewinder volcanic series of probable Jurassic or Triassic age; the monzonite is believed to be of late Jurassic age.[62] The vein strikes northwest and dips 35° to 45° southwest and is exposed laterally for about 3000 feet.

The principal workings center about two inclined shafts, the Dohney shaft, and the Armstrong shaft. The Dohney shaft, the earlier of the two, is said to be about 600 feet deep,[63] and to have four levels, spaced at 100-foot intervals and with drifts totaling 1000 feet, 1300 feet, 400 feet, and 300 feet respectively.[64] At the 200-foot level the shaft is joined by a southwest-trending, cross-cut adit. The Armstrong shaft, sunk in the period 1928-31, is about 800 feet deep. The property also contains several shallower shafts. The combined length of the workings totals about 3000 feet.

In the earlier operations ore was shipped to a mill in Victorville. In 1927-28 a cyanide mill was erected on the property, but it has been dismantled.

Supply (Gold Crown, Jean, Luhrman, Nightingale and Supply) Mine. Location: secs. 21, 22, 27, 28, T. 1 S., R. 12 E., S.B.M. (projected), in the Dale district of the Piute Mountains about 20 miles southeast of Twentynine Palms. Owner: I. W. McManaman, Twentynine Palms, California.

The Supply group, which includes the Supply and Nightingale mines, has yielded gold ore valued at about $1,000,000, the largest in the Dale district. Of this total, nearly half came from the Supply mine when operated by the Seal of Gold Mining Company and later by the United Greenwater Copper Company, both prior to 1915. The mine was idle until 1928, when it was operated briefly by the Arrowhead Development Company. The Nightingale became active when the properties were leased by the Gold Crown Mining Company in 1930. This operation, from 1930 to 1942, is reported to have yielded over $500,000. Except for minor operations by lessees, the properties have since been idle.

The Nightingale and Supply mines are on a quartz vein, cutting andesite porphyry. The vein strikes north, dips 70° to 80° E., and ranges in width from 4 to 12 feet. The Jean vein parallels the Nightingale-Supply vein about 1000 feet to the east. Gold was the principal valuable metal in the ore.

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[62] Bowen, O. E., personal communication.
[63] Nixon, E. R., personal communication.
[64] Tucker, W. B., and Sampson, R. J., Los Angeles field division, San Bernardino County: California Div. Mines Rept. 26, p. 252, 1930.

The Supply shaft was sunk on an inclination of 70° on the vein to a depth of 1250 feet. Levels at 100-foot intervals contain over 5000 feet of workings. The Jean vein was developed by a 200-foot inclined shaft; level workings were less extensive.

Operations of the Gold Crown Company were 3600 feet north of the Supply shaft. Here the Nightingale shaft, inclined 85°, was sunk on the vein to a depth of 675 feet with levels at 75-foot intervals. On the 375-foot level, 212 feet south of the main shaft, a winze was sunk to a depth of 750 feet from the surface. From the 600-foot level on this winze another winze was sunk to 825 feet, the lowest point in the mine. Underground workings total about 6000 feet. These workings developed an ore shoot 250 feet long and 9 feet in average width. The ore mined was reported to have averaged $12 per ton in gold.

The ore mined from the Supply mine was treated by dry crushing and direct cyanidation in a 100-ton mill. Ore mined by the Gold Crown Mining Company was treated in a 50-ton mill at the Gold Crown mine in Riverside County until 1938 when the mill was moved to the Nightingale. This mill process involved grinding to minus 100-mesh in a cyanide solution. A 6- by 22-foot Hardinge ball mill was employed. The gold was recovered from the cyanide solution by the Merrill-Crowe process. When operations were discontinued in December 1942, the mill was dismantled.

Telegraph Mine. Location: secs. 16, 17, 20, T. 15 N., R. 11 E., S.B.M., 17 miles northeast of Baker, and south of U. S. Highway 466. Ownership: J. B. Nosser, Johannesburg, California owns five claims.

The Telegraph mine was most active during the period 1932-38 when, according to the owner, it yielded gold valued at about $100,000. The discovery of high-grade ore in 1930 led to the development of the mine and to a brief but intensive flurry of prospecting in the general area of Halloran Spring. This activity, however, disclosed no other properties that proved as productive.

The Telegraph mine is in an area of low relief underlain principally by quartz monzonite. The gold ore was obtained from a quartz vein mostly 3 to 8 feet wide and several hundred feet long. The vein strikes N. 40° E. and dips 30° to 50° NW. An aplite dike, one to 2 feet thick, lies along the footwall of the vein.

The vein contains subordinate calcite and siderite, as well as abundant cavities partly to wholly filled with iron oxides. Also present are pyrite, chalcopyrite and traces of bornite.

The vein has been followed by three inclined shafts. At least two of these shafts are more than 100 feet deep and are joined by several hundred feet of level workings.[65] The owner reports that considerable tonnages of ore ranging in grade from $8 to $14 per ton remain in the mine.

The ore was treated by a flotation plant on the property and yielded concentrates reported to carry $300 to $400 per ton in gold. No equipment remained on the property in early 1952.

Vanderbilt Mine. Location: secs. 2 and 3, T. 14 N., R. 16 E., S.B.M. (projected), in the central part of the New York Mountains, and about 4 miles east-southeast of Ivanpah. Ownership: Allen G. Campbell estate, Leland P. Reeder, agent, 9416 Santa Monica Boulevard, Beverly Hills, owns 18 patented claims.

[65] Tucker, W. B., and Sampson, R. J., California Div. Mines Rept. 39, p. 462, 1943.

The Vanderbilt mine, one of the earliest and most productive gold-silver operations in San Bernardino County, was opened in the 1870's, and has an output valued probably at several hundred thousand dollars. The mine was most active in the late 1800's, and in the 1920's and 1930's, but has been idle since 1937.

The principal workings have explored two quartz vein systems, confined to an area about half a mile long and half a mile wide. The veins follow fractures in an Archean complex composed mostly of granitic gneiss, mica schist, quartzite, and pegmatite dikes.

The more northerly system, known as the Gold Bar-Gold Bronze, is at least 2,400 feet long. Its trace is gently curved from eastward at its east end to west-northwest, and it dips 60° to 70° northward.[66] It includes the Gold Bar veins on the Vanderbilt property and the Gold Bronze veins of the Gold Bronze mine to the east. The Gold Bar veins, two in number, average about eight feet wide, and lie one on each side of a rhyolite dike about 20 feet wide. At an average distance of 1,500 feet southwest of the Gold Bar-Gold Bronze system is the Boomerang system, which is about 1,500 feet long, strikes about N. 70° W., and dips 60° to 70° northeastward. The Boomerang system contains two veins about 100 feet apart and averaging about eight feet thick.[67]

The veins of Vanderbilt mine are characteristically heavily iron-stained for about 150 feet beneath the surface. At lower levels they contain unoxidized sulfides, notably pyrite, marcasite, galena, and chalcopyrite.[68] A typical 16-car shipment from the Gold Bar workings is said to have averaged 0.72 ounce gold, 3.50 ounces silver, 0.50 percent copper, and 0.80 percent lead[69].

The Gold Bar workings consist of three inclined shafts within a lateral distance of 500 feet. From west to east these are the Gold Bar, 425 feet deep; the Ed, 400 feet deep; and the Baldwin, 300 feet deep. These are joined by drifts, generally at 50- to 100-foot intervals, between which the veins have been extensively stoped.

A single 500-foot shaft, with five levels at 100-foot intervals comprises the Boomerang workings. Drifts range in length from 490 feet (100-foot level) to 115 feet (400-foot level). Stoping was most active above the 100-foot level.

Virginia Dale Mine. Location: sec. 20, T. 1 S., R. 11 E., S.B.M. (projected), in the Dale district about 18 miles southeast of Twentynine Palms. Ownership: Harry Hess, Morongo Valley, California, owns seven claims, two of which are patented.

The Virginia Dale mine has been operated intermittently since mid-1896 when the Virginia Dale district was first active. At that time a 5-stamp mill was moved to the mine from Twentynine Palms. Since then, the principal periods of activity have been 1908, 1928-29, and 1934-37. It probably has been one of the more significant operations in the district.

The mine area contains three parallel quartz veins which cut quartz diorite and are about 150 feet apart. They strike N. 20° W., dip 70° to

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[66] Crawford, J. J., Mines and mining products of California: California Min. Bur. Rept. 12, pp. 235-237, 1894.

[67] Crawford, J. J., op. cit.
Tucker, W. B., and Sampson, R. J., Los Angeles field division, San Bernardino County: California Div. Mines Rept. 26, pp. 255-259, 1930.

[68] Tucker, W. B., and Sampson, R. J., op. cit., p. 255.

[69] Tucker, W. B., and Sampson, R. J., op. cit., p. 257.

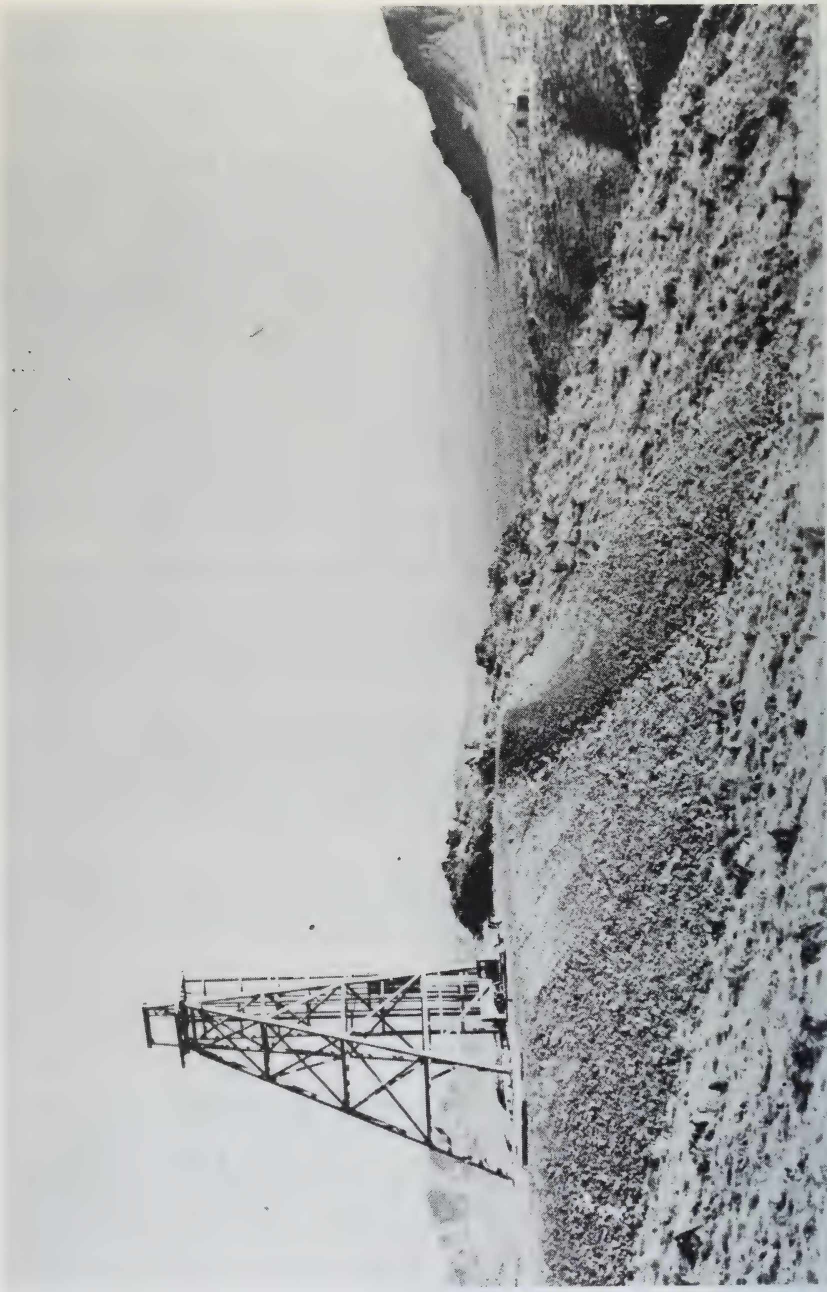

FIGURE 2. View southeast toward 325-foot vertical shaft on Contention claim of Big Horn gold mine.

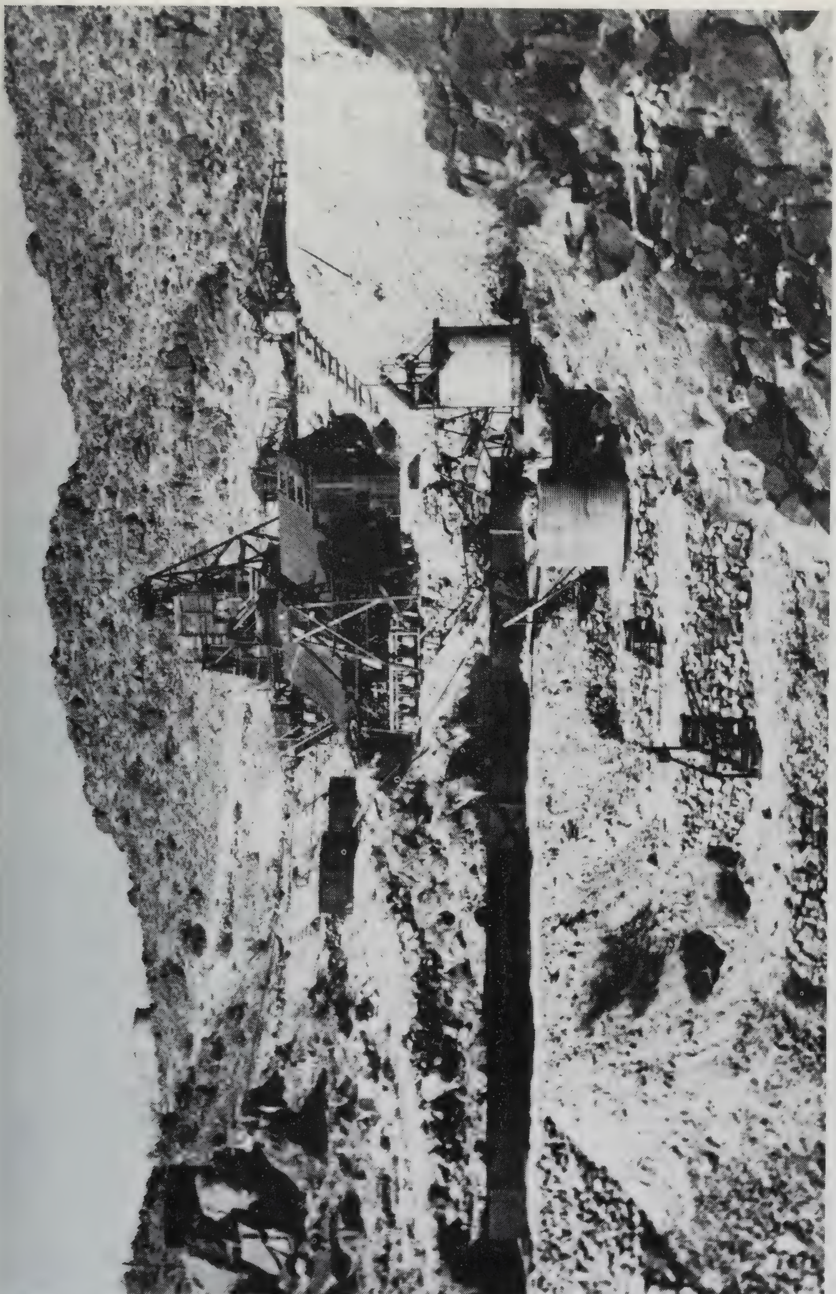

FIGURE 3. Mill and headframe of main shaft, Virginia Dale gold mine.

80° E., and range in width from 4 to 6 feet. Free gold in the quartz veins is associated with hematite, magnetite and manganese oxides. Gold values range from \$9 to \$20 per ton, averaging \$12 per ton.[70] Development work has been confined mainly to the middle vein on which a 70° inclined shaft has been sunk to a depth of 350 feet. Drifts on the 100- and 200-foot levels developed three ore shoots which ranged from 50 to 100 feet in length and averaged 4 feet in width.

A 40-ton mill on the property treated the ore by amalgamation and cyanidation. Water for milling operations was pumped 5 miles from a well at Old Dale.

Williams Well Placers. Location: secs. 20, 21, 28 and 29, T. 32 S., R. 47 E., M.D.M., in the flat country about 3 airline miles east of Superior Dry Lake, and about 14 airline miles due north of Barstow. Ownership: Various holdings.

Placer deposits in the vicinity of Williams Well have yielded small amounts of gold for many years, principally prior to 1930. Sporadic dry-placer operations recover small amounts of gold from time to time in separated portions of the area. Past production is unknown.

Weathered granitic rock forms the bedrock and is covered by as much as 15 feet of mantle carrying a small proportion of coarse-grained gold. The largest nugget found in the last 14 years was worth \$3.17. Gold values are found throughout the thickness of the mantle and do not appear to be concentrated in channels.

Old tailings piles mark the sites of former mining operations scattered over several square miles. All mining has been by dry washing methods, the machines being portable and generally operated by gasoline motors. Jasper Dodson of Barstow reports recovering several thousand dollars worth of gold from various places in the area since the late 1930's, using six such dry placer machines.

Iron

Iron deposits, ranging from small veinlets and lenses to large bodies as much as 1,000 feet in maximum dimension, are widely distributed in San Bernardino County. That several of them were known to be of commercial interest in the early nineteen-hundreds is shown by the patenting in the period 1904-08 of the Iron Age claims in the Pinto Mountains, the Iron King and Iron Mountain claims in the Silver Lake district, and a claim of the Vulcan group several miles south of Kelso. In 1916 Jones discussed the potential value of the Vulcan and other properties as sources of iron ore for a California steel industry.[71]

In spite of this early interest, production of iron ore in the county was small until late in 1942, when the Kaiser Corporation put the Vulcan mine into production. The Vulcan, which operated until July 1947, yielded 2,643,000 tons of ore for blast furnace feed at the Kaiser steel plant in Fontana.

Other properties which probably have reserves sufficient to support, at least for limited periods, plants similar to that of the Kaiser Corporation are those in the Bessemer, Silver Lake, Cave Canyon and Kingston Range areas; the Vulcan mine itself is not depleted. The Silver Lake

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[70] Tucker, W. B., and Sampson, R. J., Los Angeles field division, San Bernardino County: California Div. Mines Rept. 26, p. 259, 1930.

[71] Jones, Charles C., The Pacific Coast iron situation—The iron ores of California and possibilities of smelting: Am. Inst. Min. Eng. Trans., vol. 53, pp. 306-323, 1916.

(Iron Mountain and Iron King) and the Kingston Range (Beck) areas are undeveloped. The Cave Canyon mine has been the second largest source of iron in the county. The properties in the Bessemer area have probably yielded less than 50,000 tons of iron ore; others throughout the county have a combined total output of less than 10,000 tons.

Most of the iron ore produced at mines other than the Vulcan has been used as ship ballast or in the manufacture of high-iron cement. The urgent need of iron ore for the Japanese steel industry recently has stimulated interest in the county's iron deposits and led to the contribution of relatively small tonnages from the Bessemer and Iron Age mines during the middle part of 1951.

Nearly all the iron deposits in San Bernardino County are of contact-metamorphic bodies, existing as replacements of limestone or dolomite and genetically related to nearby granitic intrusive rocks. Magnetite and hematite are the chief ore minerals; hematite is usually subordinate.

The Iron Age deposit and probably the nearby Dorris May and Nigger Head deposits are not contact metamorphic bodies, but lie along fractures within igneous rocks.

Altuda (Globerson) Mine. Location: sec. 1, T. 7 N., R. 3 W., S.B.M., about 3 miles northwest of Stoddard Well, and about 15 miles northeast of Victorville, California. Ownership: Mr. Nathan Globerson of Alhambra and Mr. Robert Gold of Los Angeles own two claims.

The Altuda iron deposits, a series of short, narrow, magnetite- and hematite-bearing veins, occur in the Sidewinder volcanic series (Mesozoic). The property was worked briefly in 1942, and about 100 tons of high grade iron ore was shipped to Alhambra.

The veins occupy a set of east-trending en-echelon shears, 100 or more feet apart. Individual veins are as much as 75 feet long, 3 feet in maximum width, and consist mostly of dense, black, siliceous rock containing finely divided magnetite. In the center of the typical vein is a band of massive hematite as much as 2 feet thick. Locally the hematite encloses abundant magnetite tetrahedrons of pin-head size. The workings consist of a 48-foot vertical shaft on the Altuda vein and several prospect pits.

Amboy Iron Deposits. Location: secs. 7 and 18, T. 6 N., R. 12 E., S.B.M., on the southwestern slope of the Bristol Mountains. Ownership: Conn Pulos, Amboy, California owns nine unpatented lode claims and one 80-acre placer claim located for limestone.

The Amboy claims have been located to cover three separate deposits of iron ore, on only one of which has any appreciable work been done. A description of two of these, the Lillian and Magnetite has been given in a private report.[72] The Lillian deposit consists of several small lenses of hematite in limestone near a contact with granitic rock and it has been explored by a 10-foot shaft and shallow cuts. The Magnetite deposit, located about 3000 feet farther east, consists of a magnetite-hematite vein striking N. 80° W. along the contact between limestone and granitic rock; the latter contains considerable magnetite. The vein dips steeply to the south at a sharp angle to the limestone bedding which dips 60° S. The width of the vein ranges from 5 to 30 feet and the outcrop length is approximately 2000 feet. Exploration work consists of two small cuts.

[72] Penhoel, L., Private report, 1951.

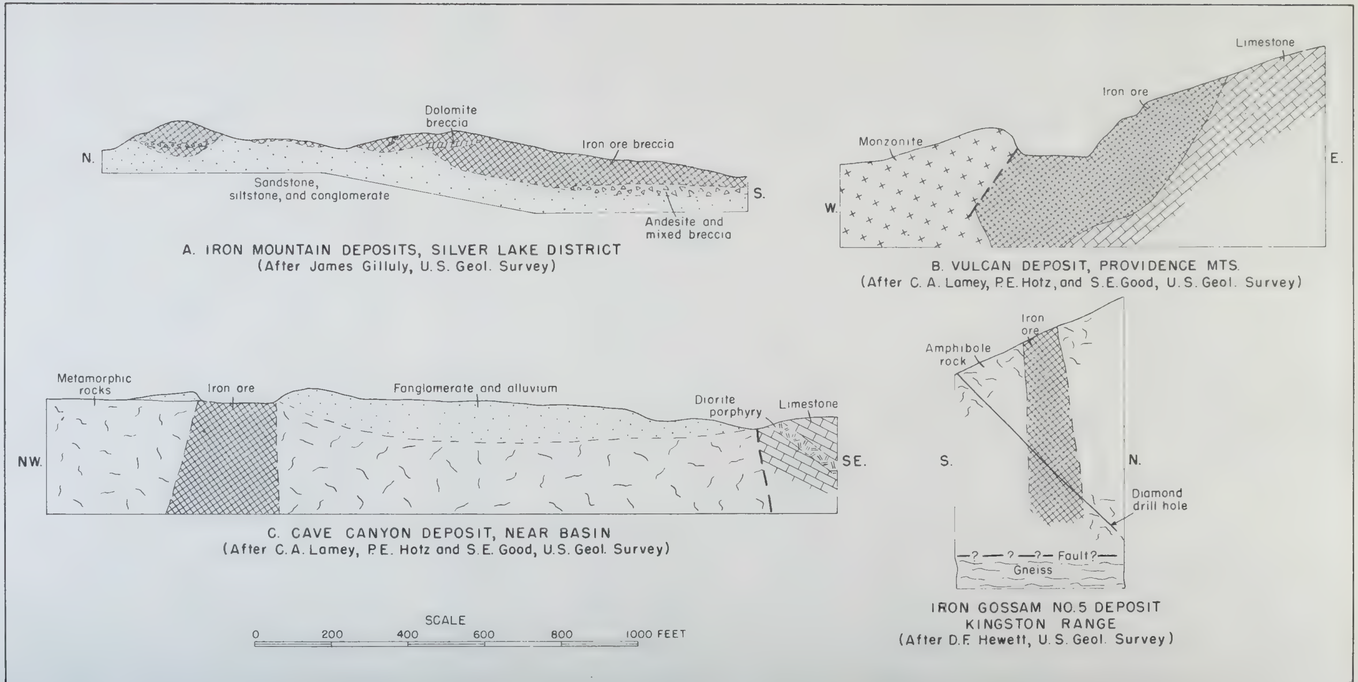

FIGURE 4. Cross-sections of representative iron deposits in San Bernardino County, after James Gilluly, D. F. Hewett, and C. A. Lamey, in California Division of Mines Bulletin 129.

FIGURE 5. View northeast toward eastern part of Iron Gossam No. 5 ore body of Beck iron deposit, Kingston Range. Entrance to Beck tunnel at lower right. Ore body crops out boldly and is bordered by limestone silicate rocks, and diabase of Algonkian Crystal Spring formation.

The Lower deposit, 1200 to 1500 feet southeast of the Magnetite deposit and several hundred feet lower in altitude, consists of a roughly elliptical lens of impure brecciated hematite in limestone; the lens is about 75 by 250 feet in size. Early in 1951 an open cut was made on the lens and a few thousand tons of low grade ore was stockpiled; no ore was shipped.

Ball Deposits. Location: secs. 3 and 4, T. 6 N., R. 2 W., S.B.M., on the northwest spur of the Sidewinder Mountains about 1 mile northeast of the Sidewinder mine, and about 14 airline miles northeast of Victorville. Owner: O. H. Ball, 2024 West 62nd Street, Los Angeles, California.

The Ball iron deposits are a group of small, little-explored, bodies of magnetite, enclosed in dolomite and scattered over an area of about a quarter of an acre. The dolomite, part of the Carboniferous Oro Grande series, is a massive unit that appears to strike eastward and dip northward. In the vicinity of the deposits the dolomite has been intruded by volcanic rocks of the Sidewinder series of Mesozoic age.

These magnetite bodies range from minute veinlets to pods 10 feet long and 2 feet thick and have been developed within the dolomite near the intrusive contact. These strike eastward, dip vertically and appear to parallel the contact. They have been explored by a few shallow prospect pits.

Beck (Iron Gossam, Kingston Range) Deposits. Location: secs. 7 and 8, T. 21 N., R. 10 E., S.B.M., near Beck Spring in the north-central part of the Kingston Range, and about 20 miles east-southeast of Tecopa. Ownership: D. E. McLaughlin Estate, 1911 Mills Tower Building, San Francisco, California, owns 6 patented claims, 16 unpatented claims and one mill site.

The Beck deposits are among the larger, though more remote, of California's iron occurrences. Although well-explored, they remained unworked in mid-1952. The deposits and general geological features of the Beck Spring area have been described in detail by Hewett.[73]

Hematite and subordinate magnetite and minor, but widespread, pyrite, form massive lenses exposed along a narrow, 6,000-foot belt. The lenses are bordered by limestone and a diabase sill which lie in the middle or upper part of the Crystal Spring formation (Algonkian). They are probably several hundred feet higher in the formation than the nearby talc-bearing belt containing the Harry Adams deposits described in the talc section of this report. The lenses and the enclosing sediments trend northwest and dip nearly vertically.

There are three principal lenses. These, from southeast to northwest, lie on the Iron Gossam Numbers 1, 2 and 5 claims and have exposed lengths of about 430 feet, 1,130 feet and 1,070 feet respectively. For most of their lengths they are from 50 to 100 feet wide. The iron oxides have formed chiefly by the replacement of limestone.

A 14-hole diamond drilling project undertaken by the Pacific Coke and Coal Company in 1924, showed that a major, low-angle thrust fault lies beneath the Beck Spring area and truncates steeply dipping Crystal Spring units, bringing them into contact with Archean gneiss. This fault limits the downward extent of the Iron Gossam Number 5 at depths in the probable range of 450 to 600 feet. The gneiss was not reached in drilling in the area of the other two lenses which appear to extend to depths of at

[73] Hewett, D. F., Iron deposits of the Kingston Range, San Bernardino County, California: California Div. Mines Bull. 129, pp. 195-206, 1948.

least 250 feet. The Iron Gossam Number 5 lens also has been penetrated by a 300-foot drift driven northwestward from its most southeasterly exposure and by a 65-foot shaft.

Bessemer (Bessemer and Western, Iron Mountain) Mine. Location: secs. 27, 28, T. 6 N., R. 4 E., S.B.M., about 26 airline miles southeast of Daggett and about 16 airline miles northeast of Old Woman Springs. Ownership: Bessemer Mines, Incorporated, controlled by James B. Utt and John Knox, Santa Ana, California, owns 6 claims.

The Bessemer properties, although prospected extensively, were not actively worked until 1945 when the Mineral Materials Company of Alhambra, California leased two of the claims and produced 2,000 tons of iron ore. Early in 1951, the American Forge Company of Oakland, California, operating on a contract, mined and shipped about 10,000 tons of ore to the Riverside Cement Company at Oro Grande. Later in 1951, Transhippers, Incorporated, Los Angeles, produced approximately 16,000 tons of iron ore for shipment to Japan.

Lamey, in summarizing a survey made in 1942,[74] estimates that the deposits contain 1,800,000 tons of ore of all grades, 30-65 percent iron, not more than 25 percent of which would be workable at normal peacetime prices.

The Bessemer deposits consist of 14 individual bodies of iron ore ranging in surface area from 2,500 to 50,000 square feet. These are contact-metamorphic deposits, most of which are enclosed in diopside-epidote garnet rock or skarn, along a contact zone between dolomitic limestone and granitic rock. The predominant ore mineral is magnetite but secondary hematite and limonite are present. Gangue minerals within the ore bodies are principally calcite and dolomite.

The four largest of the fourteen bodies contain 72 percent of the total estimated tonnage. The grade of the ore ranges from 60 to 65 percent iron in those deposits consisting almost wholly of magnetite and subordinate hematite to 30 or 40 percent iron in some deposits consisting of magnetite and hematite disseminated in dolomite.

The ore bodies and the dolomite with which they are associated trend north to northeast. The selective replacement by magnetite along bedding planes in dolomite is clearly shown. The dolomite generally dips from 30° to 40° southeast, but near intrusive contacts its attitude is irregular.

In attempting to maintain grade, the ore has been selectively mined in open pits. Ore mined by Transhippers, Incorporated, was crushed to a minus-7-inch size, sorted to remove waste, then hauled by truck 23 miles to a loading dock at Lavic.

Black Jack Deposit. Location: sec. 24, T. 6 N., R. 12 E., S.B.M., near the southeast end of the Bristol Mountains, about 5 airline miles northeastward from Amboy. Ownership (1944): J. W. Gray, Ludlow, California owns 10 claims.

Only a minor amount of iron ore has been produced from the Black Jack property. The indicated reserves are small. Six small irregular lenses of iron ore, principally magnetite, have formed along bedding planes in dolomite. The dolomite (Paleozoic) occurs as small remnant bodies in Mesozoic granite along the crest of a ridge at an altitude of 1,800 to 2,000 feet. The six lenses, the largest of which is 65 feet long and 25

[74] Lamey, Carl A., Iron Mountains iron-ore deposits, Lava Bed District, San Bernardino County, California: California Div. Mines Bull. 129, pp. 27-38, 1948.

FIGURE 6. View northwest toward main quarry face at Cave Canyon iron deposit.

feet wide, have an aggregate length of 220 feet and an average width of 10 feet. A sample of the ore is reported by the U. S. Bureau of Mines to assay 55.12 percent iron, 4.68 percent silica, 0.10 percent sulfur and 0.003 percent phosphorus. Small cuts on the individual lenses and a bench at the north end of the group of lenses constitute the work on the deposit.

Cave Canyon (Baxter, Basin) Mine. Location: secs. 11 and 12, T. 11 N., R. 6 E., S.B.M., one-half mile north of Basin (formerly Baxter) siding on the Union Pacific Railroad, and about 20 miles southwest of Baker. Ownership: California Portland Cement Company, 601 West 5th Street, Los Angeles, California owns 11 patented claims.

The Cave Canyon deposits, intermittently mined since 1930, have been a source of iron ore used in the manufacture of cement. The most complete description of the deposits has been furnished by Lamey.[75]

The iron-bearing minerals, principally magnetite and hematite with subordinate limonite, occur in bodies that lie largely within an east-northeast trending belt about one mile long. The deposits are enclosed in a complex of metamorphic rocks (limestone, gneiss, quartzite, and schist) of possible pre-Cambrian age. The complex also contains intrusive bodies of acidic to basic igneous rocks. Fragments of wall rocks are commonly abundant within the iron-bearing deposits. In general, the deposits and the enclosing rocks trend east-northeast and dip at gentle to steep angles. Intricate faulting, brecciation, and simple to complex folding are characteristic.

The deposits are exposed along the south side of a small valley with a relief of about 200 feet. Their width and lateral extent are obscured by Quaternary alluvial valley fill, talus and an older Quaternary fanglomerate. The exposed iron-bearing material lies in two principal areas, one at each end of the belt. The two bodies thus indicated are each at least 1,800 feet long and as much as 300 feet wide. A few much smaller deposits lie within a few thousand feet of the principal zone. The mineralized zone appears to be of contact metamorphic origin and largely a replacement of limestone.

Nearly all of the mine's output has been obtained from an open cut on the west body. Early in 1952 the cut, tadpole-shaped in plan, was about 800 feet long, 200 feet in maximum width and had faces mostly in the range of 30 to 70 feet high. Other workings include several shafts, adits and trenches. The maximum shaft depth is about 150 feet. The maximum adit length is about 580 feet. Mining operations were being confined to periods of a few weeks spaced at about two-year intervals.

Copper World Mine. Location: sec. 23, T. 2 N., R. 11 E., S.B.M. (projected), on the southwest slope of the Bullion Mountains about 16 airline miles northeastward from Twentynine Palms. Ownership: Arthur C. Becker, 8724 Dalton Avenue, Los Angeles 47, California, owns 6 claims.

In the only serious effort to mine the Copper World iron deposit, about 1,000 tons of ore were removed in the mid-1940's and shipped to the Los Angeles area.[76] Reserves are small.

[75] Lamey, C. A., Cave Canyon iron ore deposits, San Bernardino County, California: California Div. Mines Bull. 129, pp. 71-83, 1948.

[76] Becker, A. C., Oral communication.

FIGURE 7. View northwest toward workings on Iron Age iron deposit. Ore quarried from cut at top of hill. Iron ore outcrops silhouetted on left slope of hill.

The deposit, a magnetite-hematite lens within Mesozoic quartz diorite, is about 300 feet long, and 8 to 20 feet wide. The lens, as exposed along the southwest bank of a small wash, strikes N. 40° W. Its dip is steep, changing from 65° SW. near the top of the outcrop to 65° NE. near the floor of the wash. The contact between the quartz diorite and the iron ore is exposed only on the southwest side of the lens. A thin seam of chlorite schist is developed along this contact and chlorite also extends into the iron ore.

The lens had been prospected by cuts and a short cross-cut adit. A large part of the lens has been blasted to the floor of the wash, removing the adit.

Iron Age Mine. Location: secs. 20, 29, T. 1 S., R. 13 E., S.B.M. (projected), on the north side of the Pinto Mountains about 22 airline miles eastward from Twentynine Palms. Ownership (1944): Three patented claims are owned by D. Rhea Igo Estate, Maude Igo, Mill Creek Canyon, Mentône, California; Marcus Pluth Estate; and Carrie and R. H. Sayers; all are leased to the Ferro Company, George McDonald, H. Evan Roberts and H. B. Alexander, 135 San Vicente Boulevard, Santa Monica, California.

The only serious effort to mine the Iron Age deposit was made in 1951 and resulted in the production of between 1,300 and 1,400 tons of iron ore. Reserve estimates made in the past probably have been higher than recent explorations justify. Several iron ore bodies exist in the mine area; these have filled fissures and brecciated zones in granitic rock and have been estimated to have a combined length of 1,200 feet, and an average width of 15 feet. If an average depth of 25 feet is assumed, these dimensions indicate a reserve of about 50,000 tons. The ore bodies strike northward and dip vertically to 60° westward. The largest is conspicuously exposed on a ridge upon which recent explorations have centered.

Hematite, the principal ore mineral, has altered from primary magnetite which is present in subordinate proportions.[77] Assays of 20 samples are reported to average 67.27 percent iron, 3.32 percent silica, 0.032 percent sulfur and 0.6 percent phosphorus. Other reported assays show from 51.62 to 65.18 percent iron, 10.84 to 3.33 percent silica, 0.03 to 0.08 percent sulfur and 0.069 to 0.120 percent phosphorus.

A bench has been cut into the east side of the largest ore body at the crest of the ridge. Broken ore was moved by power shovel and trucks to the crushing plant on the slope below the ore body. A 30- by 40-inch Traylor jaw crusher and Symons screen were set to produce a minus 8-inch plus ½-inch product. In July 1951 this operation produced the 1,300 to 1,400 tons of ore noted above. The property was idle early in 1952.

Iron Hat Iron (Ironclad) Deposit. Location: secs. 17, 18, 19, 20, 21, T. 6 N., R. 14 E., S.B.M., on the southwest slope of the Marble Mountains about 6 airline miles north of Cadiz. Owner: Arthur L. Doran, Barstow, California; leased to Riverside Cement Company, 621 South Hope Street, Los Angeles, California.

The Iron Hat iron deposits have about 85,000 long tons of ore indicated by exploration openings and surface exposures and an additional

[77] Harder, E. C., and Rich, J. L., The Iron Age iron deposit, near Dale, San Bernardino County, California: U. S. Geol. Survey Bull. 430, pp. 233-234, 1910.

inferred reserve of about 200,000 long tons.[78] The total output of about 2000 tons of ore was obtained some years ago.

Lamey, who studied the deposits in 1943,[79] reports that they are small, apparently shallow lenses that occur almost entirely in Cambrian (?) limestone near contacts with intrusive granite and meta-igneous rocks. The deposits are scattered throughout an area 6000 feet long and 1000 feet wide. The largest of the three principal bodies in the northeast quarter of sec. 19, has a surface area of only 30,000 square feet. All deposits consist of the ore minerals magnetite and hematite in a gangue composed mostly of garnet, epidote, serpentine and calcite. The bodies are contact metamorphic replacements related to the granite intrusion.

The ore was mined from short adits and open cuts on the largest ore body noted above. It is reported to have averaged 65 percent iron.[80] Analyses of seven samples collected in recent investigations, averaged about 59 percent iron, 0.019 percent phosphorus, 4.9 percent silica, and 0.03 percent sulfur.[81]

Iron King Deposit. Location: secs. 18 and 19, T. 15 N., R. 7 E., S.B.M., about 1½ miles east-southeast of the Iron Mountain deposits described below, and about 12 miles west of Silver Lake settlement. Ownership: Kaiser Steel Corporation, P. O. Box 217, Fontana, California, owns one patented claim.

The Iron King deposits, like the nearby Iron Mountain deposits, have not been worked. They consist essentially of lenses of hematite- and magnetite-rich breccia occurring in the lower part of a much larger breccia body composed chiefly of limestone, and lying upon Tertiary sandstone.

As noted by Lamey,[82] most of the Iron King deposits lie along the south side of a west-trending ridge. Some of the lenses contain a high proportion of waste. The largest lens, which is about 250 feet in maximum dimension and dips steeply northward to a depth probably greater than 100 feet, is of a high grade and contains an estimated 375,000 tons of potential ore.

Iron Mountain Deposits. Location: secs. 11, 12, 13, 14, T. 15 N., R. 6 E., S.B.M., in a group of hills at the south end of the Avawatz Range, and about 12 miles west of Silver Lake settlement. Ownership: Kaiser Steel Corporation, P. O. Box 217, Fontana, California, owns 6 patented claims.

The Iron Mountain iron deposits are exposed in a belt about one mile long and 2000 feet wide. Although the deposits are generally of good grade and are among the largest in the county, they remain unworked largely because of their remoteness. They consist of numerous lenses, composed chiefly of hematite and magnetite fragments, and lying near the base of a more extensive breccia consisting mostly of limestone. In the vicinity of the deposits the breccia exists as a capping upon Tertiary sandstone and shows thicknesses no greater than 200 feet. In general,

[78] Lamey, Carl A., Iron Hat (Ironclad) iron-ore deposits, San Bernardino County, California: California Div. Mines Bull. 129, p. 108, 1948.
[79] Lamey, Carl A., op. cit., pp. 99-109.
[80] Lamey, Carl A., op. cit., p. 99.
[81] Lamey, Carl A., op. cit., pp. 108-109.
[82] Lamey, C. A., Iron Mountain and Iron King iron-ore deposits, Silver Lake district, San Bernardino County, California: California Div. Mines Bull. 129, p. 153, 1948.

the breccia dips gently eastward. It has been interpreted by some as the plate of a low-angle thrust fault; by others as a sedimentary breccia. To the west and south the sandstone and breccia are flanked by igneous rocks, principally quartz monzonite and andesite.

The larger iron-rich lenses are from 500 and 1000 feet in exposed length and as much as 100 feet thick. Of the iron minerals, hematite is the most abundant, magnetite is very common, and limonite is widespread, but subordinate to the other two. Some of the lenses are composed almost wholly of these three minerals; others contain from 10 to 50 percent waste rock, including limestone, lime-silicate alteration rock, andesite, and quartz monzonite. Some of the fragments show limestone partly replaced by magnetite. These, together with the presence of abundant silicate alteration minerals indicate an original contact-metamorphic origin for the magnetite.

In 1943 and 1944 the deposits were mapped in detail by members of the U. S. Geological Survey.[83] In a U. S. Bureau of Mines project in 1944 the deposits were explored with 12 diamond drill holes.[84] These projects led to a conservative estimate of about 6 million tons of indicated and inferred ore. The deposits have been otherwise explored by several shallow shafts and short tunnels. Ore samples analyzed by the Kaiser Company and by the U. S. Bureau of Mines averaged between 54 and 60 percent iron.

Morris Lode Deposit (Van Buren Group). Location: sec. 12, T. 5 N., R. 4 E., and sec. 7, T. 5 N., R. 5 E., S.B.M., about 30 airline miles southeast of Daggett. Ownership: Kaiser Steel Corporation, P. O. Box 217, Fontana, California owns 23 claims.

The Morris lode iron deposit was first noted in surface outcrops on two small hills about 1100 feet apart, but its extent was not known until early in 1944 when, in a magnetometer survey by the U. S. Bureau of Mines, an anomaly was noted beneath an alluvial cover in section 12 between the hills. This survey and a subsequent diamond drilling program in 1944 and 1945 were described in 1947.[85] Nine holes were drilled in an area about 1,000 feet wide and 1,500 feet long to test the magnetic anomaly. The holes, all vertical but one, ranged in length from 150 to 955 feet; eight of them penetrated an ore zone ranging in indicated thickness from 87 to 921 feet. Analyses of the ore encountered averaged 37.32 percent iron.

The ore consists of magnetite, with small proportions of pyrite, hematite and limonite, in a brecciated silicated rock containing diopside and minor proportions of calcite and epidote. The magnetite grains range in size from 20 to 150 mesh and are intimately intermixed with the gangue minerals. It is believed [86] that magnetite was introduced after the formation of the contact silicate rocks, and following the intrusion of Jurassic granodiorite into Archean (?) dolomite.

[83] Lamey, C. A., Iron Mountain and Iron King iron-ore deposits, Silver Lake district, San Bernardino County, California: California Div. Mines Bull. 129, pp. 39-58, 1948.
[84] Summary of Bureau of Mines exploration projects on deposits of raw material resources for steel production: U. S. Bur. Mines Rept. Inv. 3801, 1945.
[85] Wiebelt, F. J., Bessemer iron project, San Bernardino County, Calif.: U. S. Bur. Mines Rept. Inv. 4066, 13 pp., 1947.
[86] Lamey, A. C., Iron Mountain iron-ore deposit, Lava Bed district, San Bernardino County, Calif.: California Div. Mines Bull. 129, p. 33, 1948.

In 1949-50 the property was operated by a lessee who produced 17,500 tons of ore for use by a cement company.[87] The workings consist of open cuts on the surface exposures and a 55-foot vertical shaft.

Old Dad Mountain Deposits. Location: probably sec. 13 or 14, T. 12 N., R. 10 E., S.B.M., on northwest slope of Old Dad Mountain, and about 15 miles southeast of Baker. Owner: Mineral Materials Company, 1145 Westminister Avenue, Alhambra, California.

The Old Dad Mountain iron deposits, though within 10 miles of the Union Pacific Railroad, remain unworked. They have been described in detail by Lamey,[88] who estimated an indicated and inferred reserve of between 400,000 and 500,000 tons of potentially commercial ore. The deposits consist of massive magnetite-hematite lenses which are contact-metamorphic replacements of limestone mostly within a zone about 700 feet long and 250 feet wide. They are enclosed by highly fractured and faulted quartzite and limestone of pre-Cambrian or Paleozoic age. Nearby are irregular masses of intrusive monzonite which are probably genetically related to the iron-bearing bodies.

In general, the bodies and the rocks in which they occur strike northeast and dip vertically or steeply northwest. There are two principal bodies. One has an exposed length of about 370 feet, a maximum width of 70 feet, and a probable depth of 150 feet. The other is nearly circular in plan, has a maximum surface dimension of about 170 feet, and is at least 80 feet deep. At least 15 percent of the volume of the iron-bearing bodies is believed to consist of waste material. Sulfides, principally pyrite, chalcopyrite, and pyrrhotite (?) locally comprise at least 5 percent of their volume. The other impurities are chiefly calcite, quartz and gypsum.

The largest body, which lies on the northwest slope of a ridge, has been partly explored by two adits; both trend southward to southwestward. The lower adit is about 100 feet long. The other is 58 feet higher and is about 20 feet long.

Ship Mountain Mine (Paul Deposit). Location: secs. 11 and 12, T. 5 N., R. 15 E., S.B.M., about 3 airline miles southeast of Siam. Ownership: I. F. Crosby, 1711 South Kingsley Drive, Los Angeles, Charles A. Palmer, 1216½ Mariposa, Los Angeles, and Earl W. Paul, 967 South Marengo, Pasadena, California, own 11 claims.

The Ship Mountain mine was probably first worked in 1918. Shipments in that year amounted to about 1500 tons of iron ore reported to have had an average grade of 60 percent iron and a low sulfur and silica content.[89] The property has since been inactive. Reserves, according to Lamey, total 42,000 tons indicated and 38,000 tons inferred.

The mine area contains lenses of iron ore, principally brecciated hematite with a minor proportion of magnetite, which occur in brecciated igneous and metamorphic rocks. The lenses and enclosing rocks strike north and dip about 35° east. The ore-bearing belt, about three quarters of a mile long, is flanked on the east by overlying Tertiary (?) volcanic rocks, and on the west by Quaternary fanglomerate. The individual lenses are discontinuous. The two longest are about 300 feet in length; the average width is 2 to 3 feet.

[87] Powell, K. B., Personal communication, 1952.
[88] Lamey, C. A., Old Dad Mountain iron ore deposit, San Bernardino County, California: Calif. Div. Mines Bull. 129, pp. 61-67, 1948.
[89] The data in this section were obtained largely from the following reference: Lamey, C. A., Ship Mountain iron-ore deposit, San Bernardino County, California: California Div. Mines Bull. 129, p. 116, 1948.

FIGURE 8. View northeast toward excavation at Vulcan iron deposit on west slope of Providence Mountains. Monzonite exposed in foreground; early Paleozoic limestone behind quarry. Auto at lower left shows scale of photograph.

An inclined shaft has been sunk on the largest lens for a distance of 365 feet. There are 6 levels with about 830 feet of drifts and crosscuts. The shaft has an inclination of 35° E. at the collar but flattens to 20° near the bottom. From the bottom, a 61-foot crosscut has been driven to the east. The shaft is partly caved and is inaccessible below 325 feet. Ore was stoped from the three upper levels.

Vulcan Mine. Location: secs. 25 and 36, T. 10 N., R. 13 E., S.B.M., on the western slope of the Providence Mountains, and about 9 miles south of Kelso, a station on the Union Pacific Railroad. Ownership: Kaiser Steel Corporation, Fontana, California, owns 7 claims.

During its period of operation, extending from December 1942 to July 1947, the Vulcan mine yielded 2,643,000 tons of blast furnace grade ore for use in the initial production of the Kaiser Steel plant at Fontana. Suspension of the operation came with the Company's acquisition and development of the Eagle Mountain deposits in Riverside County.

The most detailed description of the Vulcan deposits has been provided by Lamey,[90] who in 1944 estimated a reserve of about 6 million tons of ore containing 50 or more percent iron.

The principal ore body has an ovoid outcrop pattern about 700 feet long and 325 feet wide. It is bordered mostly by Cambrian (?) limestone which strikes northwest and dips gently to moderately northward. Along its southwestern side the body is in fault contact with post-Cambrian monzonite. At its western end the body extends beneath fanglomerate. It probably plunges moderately to steeply westward.

A poorly exposed, smaller body, lying about a quarter of a mile to the southeast, is bordered on the north by limestone, on the south by monzonite. On the basis of dip-needle observations, it is believed by Lamey[91] to be about 700 feet long, 50 to 75 feet wide and to dip northward.

The ore bodies are composed of magnetite and hematite with local, subordinate limonite. They contain calcite, serpentine, and pyrite as the principal gangue minerals. Extensive sampling has shown that the principal ore body averages more than 50 percent iron. Sulfur analyses of drill samples, when averaged, show a general downward increase of from 0.66 percent, at depths of 0 to 50 feet, to 1.51 percent at depths of 250 to 300 feet.

The mine workings now consist of a pit with walls 100 to 250 feet high. It is about 1000 feet long and 500 feet in maximum width, and contains remnants of benches, each now of small area. The ore was trucked over a company-built, paved road to Kelso from where it was shipped via the Union Pacific Railroad to Fontana.

Lead-Silver-Zinc

Lead-silver-zinc minerals in San Bernardino County occur typically in replacement deposits in Paleozoic carbonate rocks. Most of the deposits have been relatively small and worked intermittently. In most deposits, lead is predominant; zinc is predominant at the Carbonate King Zinc mine and at the Cucamonga Zinc deposit, both described below. Most of the silver produced in the county has come from silver mines at

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[90] Lamey, C. A., Vulcan iron-ore deposit, San Bernardino County, Calif.: California Div. Mines Bull. 129, pp. 87-95, 1948.
[91] Lamey, C. A., op. cit., pp. 90, 91.

Randsburg and Calico rather than from these base metal mines. Some of the mines have yielded significant quantities of copper. The total value of lead produced from 1900 through 1950 is $938,899.

Blue Bell (Hard Luck) Mine. Location: sec. 27 (?), T. 14 N., R. 7 E., S.B.M., 6 miles north of U. S. Highway 91, and 7 miles west of Baker. Owner: Mr. F. C. Baker, Barstow, California; leased by Roy V. Waughtel, Manix, California.

The Blue Bell mine, which was originally worked in 1949 and was shut down in 1950, has a total output of about 80 tons of lead-silver-copper ore. The known, minable ore bodies, now removed, occurred as disconnected, variously shaped lenses and veins in limestone near irregular, intrusive contacts with granitic rock. The bodies, including the one at the Little Mike mine described under copper in this report, are unevenly distributed over an area of about 2 square miles. The bodies followed by the mine workings ranged from 10 feet to 100 feet in maximum dimension. The ore, composed principally of chrysocolla, malachite, cerussite, galena, and chalcopyrite in a carbonate gangue, is reported by the lessee to have averaged about 11 percent lead, 4½ percent copper, and 4 ounces of silver per ton. The Blue Bell mine workings consist of several sinuous adits, commonly appended to and joined by irregular stopes.

Blue Buzzard Lode. Location: secs. 25 and 36 (?), T. 16 N., R. 13 E., S.B.M. (projected), about 3 airline miles south of Mountain Pass, and about 32 airline miles east of Baker. Owner: Estate of Jane Frost Boggs, Leonard R. Fayle, executor, 21 Boggs Building, 319 Fremont Street, Las Vegas, Nevada.

FIGURE 9. Old buildings at the Bonanza King camp and town of Providence. Volcanic rock at top of hill and some of the underlying tuff were quarried to provide stone for many of the buildings.

FIGURE 10. View northwest toward Bonanza King shaft and adit workings.

The Blue Buzzard mine, a small lead-silver operation from which little or no ore has been shipped, was located in 1917 and was last active in 1947 and 1948. The ore minerals are in a chloritic shear zone in a limestone unit which underlies much of the Mescal Range. The zone strikes northwest, dips southwest and parallels the limestone bedding. Granitic rock is exposed several hundred feet east of the mine workings.

The zone is leached, and heavily stained with iron oxides. It is mostly from 2 to 5 feet wide in exposed width, and can be traced laterally for about 50 yards. The main workings consist of a shaft inclined on the vein 50° west to a depth of 90 feet. At its bottom a 30-foot drift extends northward. At the end of this drift is a 20-foot raise on the vein. Most of this work was done prior to 1920.

C. and K. (Bell Gilroy, Bell McGilroy, Lead Capping, McGilroy) Mine. Location: sec. 9, T. 10 N., R. 14 E., S.B.M. (projected), on the east slope of the Providence Mountains about 21 airline miles northwest of Essex. Ownership: Jack Rilance estate, Portland, Oregon, owns 5 claims all of which are leased to James D. Harley, 4325 Gaviota, Long Beach, California.

The C. and K. mine, worked intermittently from as early as the 1880's until recent years, has yielded only a small tonnage of ore. The deposits consist of argentiferous galena distributed through a silicified breccia zone in Paleozoic (Cambrian ?) limestone. The zone, as described by Tucker,[92] ranges in width from 400 to 600 feet, strikes north and dips 30° to 40° E. The principal ore bodies are developed at intersections of north- and east-striking fractures. The ore as mined is reported to have contained 6 to 12 percent lead and about 20 ounces of silver per ton.

Four adits, driven into the ore-bearing fissures at different levels, range in length from 65 to 300 feet. A small amount of stoping has been done in two of the adits.

Late in 1947 the property was leased by the C. and K. group, T. J. Carman and Albert Kinney. A small portable Beam smelter was erected at the mine and some runs were made. Early in 1948 a Mace smelter, with a capacity of 100 tons per day, and a small concentrating plant were erected at Fenner, but operations were not completely successful. In addition 50 tons of ore was shipped to the U. S. Smelting, Refining and Mining Company at Salt Lake City, Utah.

In March 1949, the lease was acquired by James D. Harley, the present lessee. A dump at the mine reported by Harley to contain material averaging 8 or 9 percent lead, was worked over and some hauled to Fenner for concentration. A total of 18 or 20 tons of concentrate, in three small shipments, was sent to Salt Lake City.

In April 1950, the property, including the smelter at Fenner, was sub-leased to the Fenner Smelting Company, George Warren and Robert Hollingworth, 345 South Grand Avenue, Los Angeles, California, who still are sub-lessees. During 1950 several smelting runs were made, using small charges. A total of 50 tons of ore, all from the C. and K. mine, were smelted. Late in 1951 the mine and smelter were idle.

Carbonate King Zinc Mine. Location: sec. 4, T. 15 N., R. 14 E., sec. 32, T. 15½ N., R. 14 E., S.B.M., on west slope of Kokoweef Peak,

[92] Tucker, W. Burling, San Bernardino County: California Min. Bur. Rept. 17, p. 360, 1921.

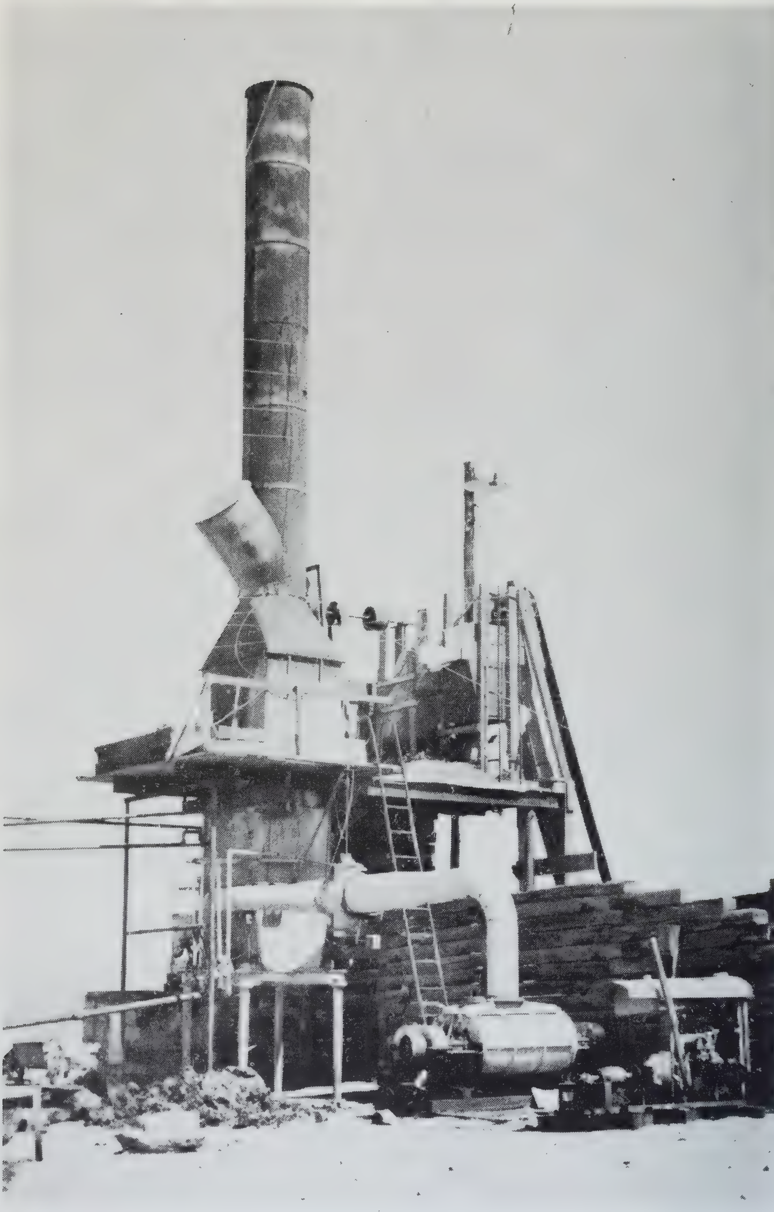

FIGURE 11. One-hundred-ton Mace smelter at Fenner, used to treat ore from the C. and K. mine in Providence Mountains.

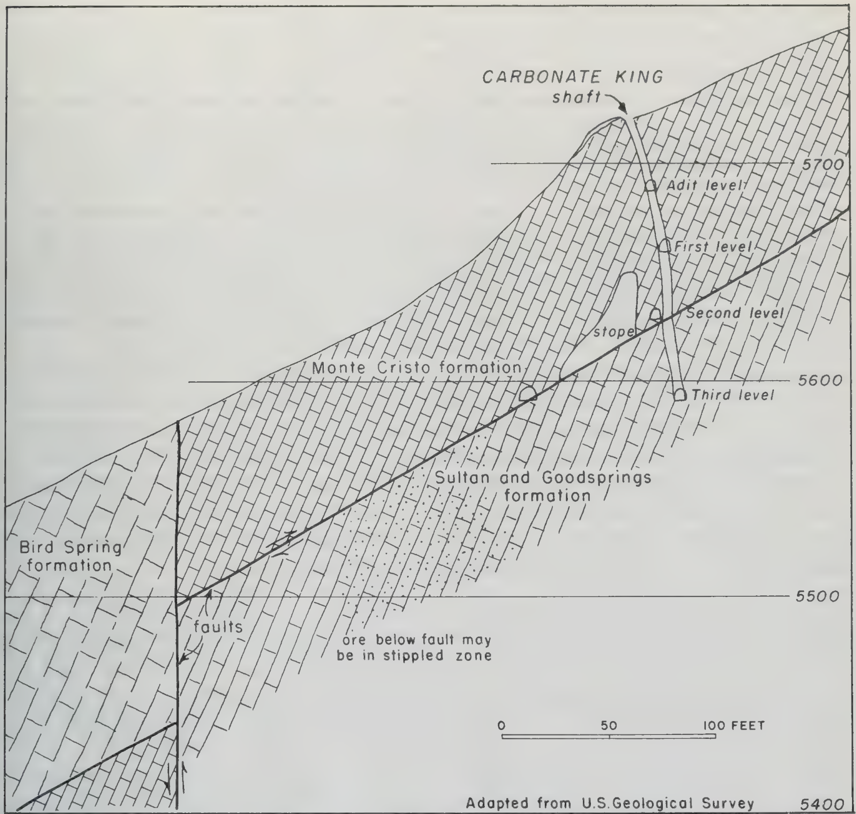

FIGURE 12. Geologic cross-section through the Carbonate King zinc mine, after Arthur Richards and A. L. Brokaw, U. S. Geological Survey.

and five miles southeast of Mountain Pass. Owner: Crystal Cave Mining Company, Las Vegas, Nevada, owns 14 claims, all of which are leased to J. Little, Mountain Pass, via Nipton, California.

The deposits at the Carbonate King zinc mine were discovered about 1900, but were not actively worked until the property was leased by its present owners in 1940. From 1940 to 1944, the deposits yielded about 4,000 tons of ore averaging 35.5 percent zinc, 1.0 percent lead, and 10 ounces of silver per ton.[93]

"The ore body of the Carbonate King mine is in the Yellowpine limestone member of the Monte Cristo limestone. Surface showings are limited to a few small stringers; the main ore body was encountered at a depth of 60 feet. The mineralized zone is elongate parallel to the strike of the beds and has a strike length of 120 feet. In the north end of the mine it dips a little more steeply than the bedding, but at the south end it is irregular and its relation to the bedding is obscure. Minor fractures essentially parallel to the bedding or slightly steeper are believed to have acted as conduits for the mineralizing solutions. The ore wedges out laterally into unmineralized limestone and dolomite. At its base the ore body is cut off abruptly by the thrust fault

[93] Richards, Arthur, and Brokaw, A. L., Geology of the Koko Weef Mountain area, San Bernardino County, California: U. S. Geol. Survey Information Service Ext. 3726, mimeographed report 34558, 3 pp., 1944.

below which lies barren limestone. Where the thrust fault crosses the third level it is clear that the ore body bottoms cleanly on the fault surface. That the faulting is post-mineral is further indicated by the unaltered condition of the limestone in and below the shear zone, and by the occurrence of drag ore along the fault zone itself.

"The ore consists dominantly of rather loosely coherent crystals of calamine with some smithsonite. Along the bottom of the stope the ore is bluish-white botryoidal smithsonite locally altered to white hydrozincite. A few residual pods of galena are present in the southwest end of the stope, and mining operations revealed some fine-grained sphalerite.

"The known ore body has been nearly mined out, and there are no reserves in the present mine workings. Since the ore body is cut off below by a postmineral thrust fault, it is logical to assume that there is a fault segment of ore in the footwall block. The position of this footwall segment depends upon the direction and amount of displacement on the thrust fault. As already noted, the component of the displacement that lies parallel to the dip of the thrust is 80 to 120 feet. . . . The chance of finding this segment is believed to be good enough to warrant exploration." [94]

In mid-1951 development consisted of a shaft, inclined 70°—120 feet, with levels at 50, 90, and 120 feet. In 1949, a 100-foot winze was sunk and a 20-foot crosscut was driven to the north at the bottom reaching ore. About 500 tons of ore, assaying 40 percent zinc, was shipped in 1949 to International Smelting and Refining at Tooele, Utah. The mine was shut down late in 1949 when the price of zinc dropped, and was reopened in July, when the price rose. In July and August 1950, 110 tons of ore assaying 40 percent zinc, was shipped to Tooele, Utah.

Cucamonga Zinc (Blew Jordam) Deposit.[95] Location: sec. 30, T. 2 N., R. 6 W., S.B.M., near the head of the East Fork of Lytle Creek; 13 miles via U. S. Forest Service road from junction with Lytle Creek road 6¼ miles north of Fontana and 1½ miles of trail. Ownership: R. B. Lyttle, 2821 Sichel Street, Los Angeles, California, owns one patented lode claim, one unpatented lode claim, and one patented mill site.

The Cucamonga zinc deposit, though still a prospect, has attracted attention as a possible source of zinc, lead, and silver. The original claim and mill site were located by the present owner in 1930 and were patented in 1944. The other claim was located in 1951.

The deposit, on a steep east slope and poorly exposed, lies in a zone of altered limestone associated with granite and granite gneiss. Zinc-bearing garnet-epidote tactite has been noted at several localities along a belt 1000 or more feet long, but which probably contains several mineralized bodies. The limestone, in general, strikes northward and dips steeply eastward. The zinc is in marmatite, locally associated with argentiferous galena. Where exposed, the mineralized zone is 20 to 30 feet wide.

The zone has been developed by three pits and a short adit near the south end, and another pit at the north end. The owner reports that channel samples, taken through widths of 5 to 6 feet, have assayed 3.2 to 13.1 percent zinc, from a trace to 3.6 percent lead, and from 0.3 to 6.65 ounces of silver per ton.

Death Valley Mine. Location: sec. 11, T. 13 N., R. 14 E., S.B.M., 3½ miles by road southeast of Cima on the plain west of the Mid Hills or southern New York Mountains. Ownership: J. Lee Strawn, Cima, California, owns seven unpatented claims, all leased to Rose Marie Mining Company, 710 South Broadway, Los Angeles, California.

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[94] Richards, Arthur, and Brokaw, A. L., op. cit., pp. 2, 3, 1944.
[95] Much of the following description was supplied by L. A. Norman, Jr., Supervising Mining Geologist, California Division of Mines.

The Death Valley mine was opened in 1907 and was intermittently operated until 1921. From 1917 to 1921 it was worked by the present owner. The mine was inactive from June 1927, when timbers in the main shaft and surface installations were destroyed by fire, until mid-1951. At this latter date, the Rose Marie Mining Company began to rehabilitate the main (Death Valley) shaft, preparatory to reopening the mine on a lease and option from the owner. The mine has a total yield of lead-silver-gold ore valued at about $131,000.[96]

The ore has been obtained from two roughly parallel veins, within 215 feet of each other, and cutting country rock of diorite and granite.[97] The veins strike northeastward and dip moderately southeastward and are several hundred feet long. The more northwesterly vein averages about 4 feet wide, the other, about 7 feet wide. Within 60 feet of the surface, the ore minerals are principally chloro-bromides of silver; at lower levels argentite and galena predominate.[98]

Two shafts, about 1500 feet apart, have been sunk on the more northwesterly vein. The Death Valley shaft, to the northeast, is inclined 45° to a depth of 400 feet, and has levels at 100, 150, 200, and 400 feet. An ore shoot, 400 feet long, was stoped from the 200-foot level to the surface. The ore shipped from this stope is reported by the owner to have averaged 75 ounces of silver, and 0.18 ounces of gold per ton, and 2.5 percent lead. The other vein, encountered by a 138-foot cross-cut from the 400-foot level, yielded 500 tons of milling ore which the owner reports averaged 17 ounces of silver, 0.10 ounce of gold, 2.5 percent lead, and 1.5 percent zinc.

The Arcalvada shaft, to the southwest, is inclined 70° and 285 feet deep. From it a 135-foot drift has been driven northeast on the 125-foot level.

In mid-1952 the lessees were retimbering and cleaning up the Death Valley shaft, which had burned to the water line at the 150-foot level, and intended to mine from the 200- and 400-foot levels. A 30-ton mill, formerly on the property, was removed to the Owl Spring manganese mine early in 1946. The lessees plan to replace it with a 50-ton mill.

Gold Hill Group. Location: sec. 14, T. 17 N., R. 11 E., S.B.M., in Shadow Mountains about 9 airline miles northwest of Valley Wells and 25 airline miles northeast of Baker. Ownership: Shadow Mountain Mines, Paul G. McKenry, president and general manager, Nipton, California, owns 20 unpatented claims; formerly a part of Foster Mines Company holdings.

The Gold Hill mine, a small silver-lead operation, was being developed in mid-1952. In the past, high-grade pockets have been mined from numerous shafts and pits in the mine area.

The country rock is garnetiferous quartz-biotite schist and diorite gneiss which strike northward and dip 20° to 65° E. A series of quartz veins, now strongly brecciated, recemented, and mineralized follows a north-trending system of faults. The minerals, including galena and various carbonates of lead and silver, occur in a series of brecciated and recemented quartz veins lying along north-trending faults.

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[96] Tucker, W. B., and Sampson, R. J., San Bernardino County: California Div. Mines Rept. 27, pp. 348-349, 1931.
[97] Tucker, W. B., and Sampson, R. J., op. cit.
[98] Tucker, W. B., and Sampson, R. J., op. cit.

The workings include the 95-foot Carlton shaft, inclined 70° east on the principal zone of veins. This is an extension of an old exploration pit, and was being deepened in 1952. Short drifts extend northward. Two hundred yards east another quartz zone has been explored by two shafts now 30 and 60 feet deep but partly filled. Several shallow open cuts expose similar zones nearby. Half a mile south on the main zone is the Stewart shaft, described by Tucker and Sampson,[99] now deepened to a 65-foot inclined depth on the east-dipping vein.

About 100 tons of ore from the Carlton shaft were milled in 1950 at the company's newly reconstructed mill, about 4½ miles south of the mine. The mill was reconditioned in 1949 and 1950 to handle 50 tons of ore per 24-hour day.

Imperial Lode (Cave Springs Mining Corporation) Mine. Location: secs. 25 and 26, T. 7 N., R. 5 E., and sec. 31, T. 7 N., R. 6 E., S.B.M., about seven airline miles southwest of Lavic, a station on the Santa Fe railroad. Ownership: W. W. Tucker, 1425 W. Pico Blvd., and Grace Remington, 2500 Glendale Blvd., Los Angeles, California, own three patented claims.

The Imperial Lode, a quartz vein, 4 to 18 feet wide, is several thousand feet long and cuts "quartz porphyry"; it is of interest primarily for the silver-bearing minerals it contains.[100] The vein strikes N. 55° to 70° W., dips 70° SW and has been opened at numerous places in operations as early as the 1880's. The ore occurs as shoots and irregular bodies containing silver chlorides and argentite, associated with iron and manganese oxides, and commonly accompanied by subordinate cerussite, pyrite, and chalcopyrite. The principal ore bodies discovered to date have ranged from 5 feet to 18 feet wide and 30 to 50 feet long.[101]

The underground workings total about 6,000 feet in length and are confined mostly to three claims. The property was idle from 1938 to 1951, but during early 1951, the property was under option to L. A. Raisek, Box 242, Topanga, California. Raisek drove a raise from a 175-foot adit driven in an easterly direction from the west side of the Mammoth Chief claim. The raise was started on an indication of ore in the back of the adit. One shipment was made in March to the American Smelting and Refining Company at Selby.

Iron Horse (Jack Rabbit) Mine. Location: sec. 36, T. 16 N., R. 13 E., S.B.M., about 3 airline miles south of Mountain Pass in the Mescal Range of the Ivanpah Mountains about 32 airline miles east of Baker. Ownership: Tony Marteletti, 524 Linden, Las Vegas, Nevada, and W. E. Ellis, Sloan, Nevada, own two claims and one millsite.

The Iron Horse is a very small lead-silver mine from which a few hundred tons of low grade ore was shipped prior to 1941. In 1943 development work was done with the aid of a Reconstruction Finance Corporation loan but no production resulted, and the property has been idle since.

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[99] Tucker, W. B., and Sampson, R. J., op. cit., pp. 480-481, 1943.
[100] Storms, W. H., San Bernardino County: California Min. Bur. Rept. 11, pp. 349-354, 1893.
[101] Tucker, W. B., and Sampson, R. J., op. cit., p. 481, 1943.

Ore minerals consist of oxidized minerals of copper, iron, silver and lead in a vein, from a few inches to 10 feet wide, which lies along a bedding plane in limestone. The vein, which strikes north and dips 50°-60° W., is exposed as a discontinuous gossan several hundred feet west of a granite-limestone contact, and roughly parallel to it.

The main workings consist of a shaft inclined westward on the vein. It is 190 feet deep and contains drifts and stopes of minor extent. An older shaft is 100 feet to the south. To the north the gossan is exposed in a series of shallow pits and trenches for about a quarter of a mile. All machinery has been removed.

Apparently the same vein and geologic relations exist on the Blue Buzzard property about a mile to the northwest although the vein is not continuously exposed between the two workings.

Keiper (Bank Roll, Green Gold, Kieper, Valentine) Group. Location sec. 30 (?), T. 17 N., R. 13 E., S.B.M., on the west slope of Clark Mountain, 5½ airline miles northeast of Valley Wells, and 32 airline miles northeast of Baker. Ownership: G. B. Conklin, Valley Wells Station, P. O. Nipton, California, owns 12 lode claims.

Although worked at various times, the Keiper mine has not been extensively developed. Small tonnages of high-grade lead-zinc-silver ore were shipped in the 1920's and early 1930's by a former owner.

The mine workings are clustered in several areas along a belt, more than a mile long, at or near a contact between quartz monzonite and a Paleozoic unit of limestone and shale. The ore bodies, in general, are discontinuous lenses and veinlets containing galena, sphalerite, chalcopyrite and various secondary minerals. Gold and silver are also present. Some of the bodies lie along fractures and bedding planes in the limestone; others follow fractures in the quartz monzonite.

At the north end of the belt, the Glory Hole workings, as described by Tucker and Sampson,[102] have developed mineralized, siliceous lenses in the quartz monzonite. A fracture striking S. 60° E. and dipping 70° NE. has been followed by a 285-foot southeast-trending adit and a winze 150 feet from the portal. Cross fractures trending S. 30° W. have been followed southwestward from the adit by two drifts; one 30 feet long near the winze, and another 150 feet long from the adit face. About 1500 feet northeast of the Glory Hole workings, an ore body, 6 inches to 5½ feet wide at the limestone-quartz monzonite contact, has been explored by a 30-foot adit and 40-foot shaft.

In the southern part of the mine area prospect adits, totaling over 400 feet in length, have been driven eastward through the limestone by various lessees during the last ten years. Shallow openings along a zone about 350 yards long mark the removal of high grade pockets near the surface in the past.

Recent activities were confined to a mineralized area along bedding planes at a contact between calcareous shale and massive limestone. The zone strikes northward and dips 20-30° E. The ore bodies are lenticular and range from one inch to 5 feet in thickness. They contain showings of galena, but the ore minerals are mostly oxidized minerals of lead and zinc. In several places faults terminate the ore zones.

[102] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, p. 484, 1943.

Mitchell Mine. Location: sec. 21, T. 10 N., R. 14 E., S.B.M. (projected), on the east slope of the Providence Mountains near Mitchell's Caverns about 21 airline miles northwest of Essex. Ownership: J. E. Mitchell, Essex, California, owns 8 claims all of which are leased to I. F. Crosby and associates, 1711 South Kingsley Drive, Los Angeles, California.

The lead-silver deposit at the Mitchell mine has been prospected intermittently for 10 years or more, but production has been negligible. The deposit occurs in thick Permian limestone (Bird Spring formation) exposed on the east side of the Providence Mountains for several miles north and south of Mitchell's Caverns.[103] About half a mile north of the caverns which have been formed in this formation, lead mineralization has followed fissures in the limestone. The fissures strike N. 30° W. and dip steeply to the west.

Several shallow open cross-cuts have exposed ore zones ranging in width from 2 to 6 feet.[104] About 150 feet below the surface outcrop, a cross-cut adit has been driven 250 feet to the west. The present lessees have driven 160 feet of this during a period of 10 years. They have shipped no ore but report that 250 tons of ore on the dump will assay 15 percent lead and 5 ounces of silver per ton.

Mohawk Mine. Location: secs. 7, 8, 17, and 18, T. 16 N., R. 13 E., S.B.M. (projected), on the west slope of Mohawk Hill, just west of Clark Mountain Station on U. S. Highway 91, and less than one mile north of the highway. Ownership: Ivanpah Copper Company, L. D. Godshall, president, 722 South Oxford Avenue, Los Angeles, California, owns six patented and three unpatented claims, which are leased to the Mohawk Mines, Inc., a Nevada Corporation, Will Peterson, Philmore, Utah, president; subleased to Emerson Ray, Windmill, California, and S. D. Greenwood, Valley Wells, via Nipton, California.

The lead-silver-zinc deposits at the Mohawk mine were discovered and first worked during World War I. The property remained idle until 1942, but has been active since then.

The ore deposits are bodies of lead and zinc carbonates in limestone. They lie near a quartz monzonite contact. The quartz monzonite forms the southern slope of Mohawk Hill; its contact with the limestone seems to be intrusive, but is modified by faulting. The contact is irregular in detail, but strikes generally eastward, and dips about 40° southward.

Cerussite, the principal ore mineral, is accompanied by subordinate smithsonite, minor proportions of galena, sphalerite, and copper carbonates. The ore is soft, earthy, and associated with soft iron and manganese oxides. Although ore bodies are irregular in detail, they are largely confined to a zone 20 to 30 feet wide along the contact, but ore-bearing stringers and fissures also exist elsewhere in the mine area. Mineralization appears strongest where fractures cross the contact zone.

Development consists of three tunnels at different elevations driven northward into Mohawk Hill. Workings, including winzes, raises, tunnels, drifts, and stopes, aggregate over 2500 feet.

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[103] Hazzard, J. C., Paleozoic section in the Providence Mountains, San Bernardino County, California (abstract): Geol. Soc. America Proc. for 1937, pp. 240-241, 1938. Emery, K. O., and Easton, W. H., Mitchell's Caverns, California: Bull. So. California Acad. Sci., vol. 50, pp. 3-4, 1951.

[104] Tucker, W. B., op. cit., p. 485, 1943.

The operators report that recent shipments to Selby, California, have averaged 8 to 10 percent lead, 3 percent zinc, and 7 to 8 ounces of silver. From May 1951 to December 1951, about 640 tons was shipped.

Nigger Mountain (Fremont, Mohawk Zinc) Mine. Location: secs. 22, 23, 27, T. 3 N., R. 1 E., S.B.M., on steep slope near the west rim of Cushenbury Canyon and about 1 mile due west of Whiskey Springs. Owner: F. L. Tomlinson, Lucerne Valley, California.

The Mohawk is a small mine, reported by the owner to have yielded about 80 tons of lead-zinc-silver ore. Nine claims comprise the property. Exploration by the owner has continued intermittently since 1909, but the only ore shipments were made during World War II by lessees.

The principal workings consist of tunnel containing about 700 feet of crosscuts and drifts. Another tunnel, 300 feet higher, is 180 feet long. These intersect an iron oxide-rich zone in massive crystalline limestone of the Furnace (Mississippian?) formation. The zone, which apparently persists laterally for at least 1,000 feet, is as much as 15 feet wide and parallels the limestone bedding, which strikes north-northeast and dips moderately west. The ore minerals, principally galena and sphalerite, appear to occur as high-grade, but irregularly and sparsely distributed lenses in the zone. The mine has been idle since 1946. The ore shipped to the U. S. Smelting, Refining, and Mining Company, Midvale, Utah, assayed 22 percent lead, 7 percent zinc, and 20 ounces of silver per ton.[106]

Pedry Deposit. Location: secs. 6, 7 and 18, T. 10 N., R. 2 W., S.B.M., about 4 miles northeast of Hinkley school. Ownership: William Hile and associate, Nipton, California, own 6 patented claims, all leased to Fred Santchi, Bagdad, California.

The Pedry deposit consists of lead, zinc, silver, and copper minerals irregularly distributed in a quartz vein about 1 mile long that cuts several types of rocks. The vein, striking northwest and dipping 70° to the east, crops out discontinuously along the crest of a low ridge on the east side of Hinkley valley. It ranges in exposed thickness from 2 to about 10 feet.

The country rock is poorly exposed, but appears to be gray dacite or quartz latite and white porcelaneous felsite along the vein's southern part, with granite and granitic gneiss to the north.

The vein is composed chiefly of brecciated quartz and contains abundant fragments of wall rock. Barite and calcite are also common. At the surface it is vuggy and heavily stained with yellow and brown iron oxides. Sulfides include pyrite, galena and sphalerite. Cerussite and anglesite persist as deep as 200 feet. The lead minerals are reported to carry silver. Mineralized zones containing copper occur only in the northern part of the vein, and probably are not of commercial interest.

Development consists of two shafts, about three-quarters of a mile apart, and both inclined 70° to the southeast. The north shaft is 200 feet deep with short drifts at several levels. Present work is confined to the south shaft which is 270 feet deep and has 5 levels spaced at approximately 50-foot intervals. The levels consist of drifts, none longer than 30 feet, and a crosscut at the 100-foot level driven west 40 feet intersecting a parallel vein. Water was struck at 250 feet. The vein has also

[106] Tucker, W. B., and Sampson, R. J., op. cit., p. 487.

been exposed by 45 prospect pits and shallow shafts, spaced 20 to 80 feet apart between the 2 main shafts.

Since the present lessee took over in 1949, no shipments have been made but small scale development was continuing in 1952.

Scotty Wilson Mine. Location: sec. 4, T. 2 N., R. 1 E., S.B.M., in Van Dusen Canyon, about 2½ miles northwest of Big Bear City. Ownership: D. F. Gleber, 1036 Ferris Avenue, Los Angeles, California, owns two placer and four lode claims, all leased in January 1941 to Phillips Barnes and associates, Box K, Big Bear Lake, California.

The Scotty Wilson property, originally opened in the mid-1930's, in intermittent operations has yielded several tons of lead-silver-zinc ore. In 1951, the previously recognized ore minerals were found associated with radioactive material which, in specimens submitted by the lessees, was identified as pitchblende by the Atomic Energy Commission.

The mine workings, which are near the bottom of the canyon's south wall, are within and near a poorly exposed, coarse, breccia- and gouge-filled fault zone in massive limestone of the Furnace (Mississippian?) formation. The zone seems to trend about S. 60° E., dips almost vertically, and exceeds 30 feet in width. Its lateral extent is obscured by overburden and alluvium. Within the zone are elongate limestone blocks of which some are several tens of feet long. The ore minerals apparently are confined to these blocks and exist as unevenly distributed, podlike to very irregular masses composed principally of galena, pyrite, and sphalerite, and also apparently containing the pitchblende. Such masses rarely exceed 6 inches in length.

The original mine workings consisted of a 30-foot vertical shaft and a nearby south-trending adit; both are now caved or filled. Late in 1951, the present lessee had sunk a 50-foot vertical shaft about 20 feet east of the original shaft. Cross cuts southward in the fault zone extend from the 25-foot and 50-foot levels and are respectively 20 feet and 50 feet long. Most of the mineralized limestone removed in the later operation was obtained from a large block exposed in the 25-foot level, but not encountered in the 50-foot level. The property was idle in the winter of 1951.

Silver Dream (Tiptop) Deposit. Location: sec. 17, T. 2 N., R. 3 E., S.B.M. (projected), near crest of Tiptop Mountain, 11 miles east of Big Bear City. Ownership: A. Saviers, P. O. Box 3, Big Bear City owns one claim. Leased in mid-1951 to J. L. Harper and associates, 406 North Ardmore, Los Angeles, California.

The Silver Dream, a lead-silver prospect consists of an irregularly mineralized zone in massive limestone of the Furnace (Mississippian?) formation. The zone, which is about 60 feet in maximum width and at least 250 feet long, strikes west-northwest and dips moderately to steeply north, paralleling the attitude of the limestone. The zone is bordered on the north by a soft micaceous schist and grades southward into unmineralized limestone. Within the zone are several high-grade, galena-rich veins bordered by rock heavily stained with iron oxide. The veins average less than 5 inches wide, but some are traceable laterally for several tens of feet. The operators anticipate removal of the entire zone as

low-grade milling ore. The workings consist of two old shafts, each less than 30 feet deep, and several wide trenches cut during the summer of 1951.

Silver Rule (Chambers) Mine. Location: sec. 31, R. 20 N., T. 10 E., S.B.M., on northwest slope of Kingston Range and about 17 miles east-southeast of Tecopa. Ownership: John Prato, 2134 West Valley, Fontana, California, owns 5 claims.

The Silver Rule lead-silver-zinc mine was worked as early as 1910 and has been intermittently active since. The mine lies close to the Inyo-San Bernardino County line as shown on the U. S. Geological Survey Ivanpah quadrangle, and commonly has been described as in Inyo County. Most of the ore has been removed from a single shoot that is probably about 170 feet in maximum horizontal dimension and generally from 3 to 15 feet wide. The shoot lies along a shear zone in Noonday dolomite (Cambrian ?), strikes westward, dips 65° to 75° N., and is approximately parallel to the bedding in the dolomite.

The principal ore minerals are galena and secondary minerals of lead and zinc. Much of the ore mined in the earlier period assayed 20 to 40 percent lead, 7 to 10 percent zinc, and 10 to 20 ounces of silver per ton.[107] Ore obtained in recent operations has been of somewhat lower grade.

The ore shoot has been mined by stopes joined to two west-trending tunnels; the portal of one is 65 feet higher than the portal of the other. The upper or No. 1 tunnel contains about 260 feet of drifts and cross-cuts, the No. 2 tunnel about 400 feet. The No. 3 tunnel, about 60 feet lower, is 100 feet long, and trends southwest but is in barren dolomite. Two additional tunnels, much lower on the hillslope, are said by the owner to be 1,150 feet and 600 feet long, and to have been driven in barren rock. The mine was most recently operated in 1950 when about 200 feet of tunnel were driven, and several tens of tons of ore were shipped.

Yucca Metals Mine. Location: secs. 8 and 17, T. 16 N., R. 13 E., S.B.M. (projected), about ¼ mile west of Clark Mountain Station on U. S. highway 91, and about one mile from the highway. Ownership: Yucca Metals Mining Co., Joseph Rimensberger, president, Salt Lake City, Utah, owns 17 claim; all are leased to Alfred Larson, L. B. Hensley, and Sidney J. Anderson.

The Yucca Metals mine is a lead-silver deposit just east of the Mohawk mine described above. The lead ores occur in fractures in limestone. Two cars of ore shipped in 1917, carried 19 to 24 percent lead and 5 ounces of silver per ton.

Ore bodies are discontinuous, irregularly distributed pods and veinlets containing secondary lead minerals, subordinate galena, and abundant iron and manganese oxides. They lie along steeply dipping fractures that generally strike N. 50° E., or N. 40° W.

Development consists of two tunnels, each over 200 feet in length, 5 shafts from 20 to 60 feet deep, and numerous trenches and prospect pits. The shafts and trenches are widely scattered over the claims.

[107] Tucker, W. B., Los Angeles field division, Inyo County: California Min. Bur. Rept. 22, p. 500, 1926.

Manganese[108]

At about 20 localities in San Bernardino County manganese deposits have been prospected or mined on a small scale. They lie mainly in the following five areas: (1) the south end of the Owlshead Mountains; (2) the Avawatz and Silver Lake region about 25 miles south of the Owlshead Mountains; (3) the south slope of the Cady Mountains between Newberry and Ludlow; (4) Newberry Mountain south of Newberry; and (5) in the Whipple Mountains north of Parker.

Others, apart from these areas, include the Black Mountain deposit 10 miles north of Needles, and the Black Stone deposit 3 miles southeast of Afton.

Most of the deposits consist of manganese oxide minerals in brecciated zones along fissures in volcanic rocks, fanglomerate or granitic rocks. The principal manganese mineral is psilomelane but pyrolusite is usually present and may predominate locally. Calcite and hematite are commonly associated with the manganese minerals.

Those not of the fissure type include the Owl Springs, Orchard, Monument King, and Moulton deposits. The first two are bedded and of low manganese content; the Monument King and Moulton deposits consist of lenticular bodies of high grade manganese oxides associated with hematite and jasper in sedimentary rocks.

Most of the deposits are shallow and have been worked to depths of only a few feet or tens of feet. The deepest operations have been at the New Deal mine, near the southern end of the Owlshead Mountains, where a vein has been followed down dip to a vertical depth of 90 feet. The principal deposit at the Stewart mine, in the Whipple Mountains, was worked through a 50-foot vertical interval.

Because hand sorting of mined material is usually required to produce an ore of marketable grade, the mines have been most active during the periods of high demand, particularly during the two world wars. By far the most productive mine in the country has been the New Deal, production from which is reported to have been more than 15,000 tons of ore. Mines in the Whipple Mountains are probably second in output, and those in the Cady Mountains third.

Big Reef (Black Butte, Matt and Pisgah) Mine.[109] Location: sec. 10, T. 8 N., R. 6 E., at the southern base of a small hill south of the Cady Mountains, $2\frac{1}{2}$ airline miles north of Pisgah siding. Ownership: Kenneth Van Doren and C. S. Van Doren, 476 Barbour Avenue, Banning, California, own 10 claims

A total of a few hundred tons of manganese ore was produced from the Big Reef mine during the first and second world wars. Early in 1951 the Owl Springs Manganese Company leased the property and shipped 125 tons of ore containing 40 percent manganese to the Geneva Steel Company in Utah.

The area of manganese mineralization is confined to brecciated andesite. Three aligned manganese-bearing bodies, possibly on the same

[108] Trask, P. D., and others, Manganese in California: California Div. Mines Bull. 125, pp. 84-85, 160-164, 1943.
Trask, P. D., and others, Geologic description of the manganese deposits in Calif.: California Div. Mines Bull. 152, pp. 188-208, 1950.
[109] Trask, P. D., and others, op. cit., p. 191, 1950.

breccia zone, lie along a 3000-foot belt. In general, the bodies strike north-northwest and dip steeply both west and east. They consist of andesite fragments cemented by manganese oxides, principally psilomelane and pyrolusite.

The central and largest known manganiferous body is about 100 feet in exposed length and 6 to 8 feet in average width. Its foot-wall is a smooth fault-surface; its hanging wall contact is gradational. The body appears to grade into relatively barren breccia, both laterally and downdip within 25 feet of the surface. It was originally developed by two north-trending drift adits. The lower adit and appended cut were 74 feet long. The other adit and cut, 19 feet higher, were 57 feet long. In plan the adit portals were 41 feet apart. In 1944 H. W. Wier, a lessee, removed the remaining ore from the surface to the lower adit, leaving an open cut.

Ore mined from these workings in 1918 is said to have averaged 40 percent manganese.[110] Two representative samples taken in 1943, assayed 32.97 and 35.70 percent manganese, 1.29 and 1.78 percent iron, and 17.85 and 19.07 percent silica.[111]

Lee Yim Manganese (Lavic Mountains, Garringer, Manganese 1-10, Root) Mine. Location: secs. 22 and 23, T. 8 N., R. 7 E., S.B.M., about 5 airline miles northwest of Ludlow, on a spur extending southeastward from the Cady Mountains. Ownership: Lee W. Yim, Box 77, Amboy, California, owns 10 claims.

The first operation of the Lee Yim mine, during World War I, resulted in the production of 100 tons of ore which had an average grade of 38 percent manganese, 1 percent iron and 10 percent silica. Apparently no ore has been shipped since.

As noted by Wilson and Morse,[112] manganese-bearing brecciated zones, within a belt about 250 feet wide, occur along three fissures in rhyolite and rhyolite breccia. The longest fissure can be traced for a length of 2300 feet. The fissures have an average strike of N. 65° W., dip 70° N., and have a smooth, distinct footwall and a gradational hanging wall. The brecciated, manganese-bearing zones occur discontinuously along the fissures. One zone is 20 feet in maximum width, but ordinarily they are 2 to 3 feet wide and 30 to 100 feet long. The manganese oxides, partly botryoidal psilomelane, partly soft, black oxide, occur as a cement in the breccia. Calcite, jasper and hematite are associated minerals. In some places the ore is reported to grade into hematite at a shallow depth. The average grade of most of the manganese-bearing material is 25 to 30 percent manganese, but the silica content is high.

Prior to 1942, there were numerous open cuts and one 42-foot inclined shaft from which a small amount of drifting was done. In 1942 the property was leased by the Gold Hill Dredging Company of San Francisco which explored the deposit by means of several shallow shafts or pits with some drifts and crosscuts. No ore was shipped in this operation.

Logan (Trans-Oceanic, Treasure) Mine. Location: secs. 28 and 32, T. 9 N., R. 6 E., S.B.M., on the southwest slope of the Cady Mountains,

[110] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, pp. 492-493, 1943.
[111] Trask, P. D., and others, op. cit., p. 191, 1950.
[112] Trask, Parker D., and others, op. cit., pp. 195-200, 1950.

FIGURE 13. View northwest toward Monument King manganese mine; open cut and small slope in volcanic breccia. Hill in left background shows Tertiary sediments capped by Tertiary volcanic rocks.

about 18 airline miles east of Newberry, and 4 airline miles north of Pisgah siding. Ownership: E. F. Logan, San Bernardino, California, owns 6 claims.

The Logan mine was located early in 1930; the first ore shipment, 71 tons containing 44 percent manganese and 2 percent silica, was made in 1934. During 1942 and the early part of 1943 the property was leased by the Suckow Borax Mines Consolidated, Incorporated, of Los Angeles who produced approximately 300 tons of ore containing more than 40 percent manganese. Tucker [113] reports that 200 tons of ore containing 19 percent manganese was shipped to the Kaiser Steel Corporation subsequent to the Suckow operation.

The deposit, as noted by Wilson,[114] differs slightly from the typical fissure deposit of the desert region in which manganese minerals usually impregnate and cement a brecciated zone. The Logan deposit consists of well-defined veinlets which fill fractures in andesite. Most of the veinlets range in width from a fraction of an inch to 3 or 4 inches; a very few are as much as a foot wide. The fissure zone, containing the veinlets, is about 50 feet wide, 600 feet long, strikes northwest and dips northeast.

The veins contain mostly high grade manganese ore but because of their size and spacing, the grade of ore which can be produced depends upon the degree of sorting. A large proportion of waste must be sorted to produce ore containing greater than 20 percent manganese.

Ore has been mined from several open cuts distributed along 600 feet of the fissure zone. The largest of these cuts is 125 feet long and 30 feet wide. None of the cuts is more than 20 feet deep.

Monument King (Cross Roads, Hidden Cross, Hidden Treasure, Manganese King) Mine. Location: sec. 1, T. 2 N., R. 25 E., and sec. 6, T. 2 N., R. 26 E., S.B.M., in the Whipple Mountains about 9½ airline miles north of Earp and 9 airline miles west of Parker Dam. Ownership: Paul Robison, Ogden, Utah, and Mrs. Ray Siedletz, 2621 Whittier Boulevard, Los Angeles, California, own 12 claims.

The Monument King mine and the Moulton mine which adjoins it on the southeast, as noted by Jones,[115] were discovered early in 1917. Production of manganese ore during the period 1917-18, from the two properties, is reported to have totaled 160 tons containing 46 percent manganese and 3 percent each of silica and iron. In 1943 lessees on the Monument King shipped 12 tons of ore containing 39.01 percent manganese to the Metals Reserve depot at Parker, Arizona.[116] The subsequent production from the two properties probably does not exceed 1,800 tons, a figure reported by Mr. Moulton in 1943.

In the mine area a sedimentary series of probable Tertiary age rests unconformably on pre-Cambrian metamorphic and igneous rocks. The sedimentary series is composed of conglomerate, and red and brown sandstone with interbedded shale and limestone members and is overlain by volcanic breccias, tuffs and basaltic flows. Lenticular bodies of manganese oxide associated with hematite and jasper occur principally

[113] Tucker, W. B., op. cit., p. 495, 1943.
[114] Trask, P. D., and others, op. cit., pp. 200-201, 1950.
[115] Jones, E. L., Deposits of manganese ore in southeastern California: U. S. Geol. Surv. Bull. 710, pp. 190-193, 1919.
[116] Trask, P. D., and others, op. cit., p. 202, 1950.

FIGURE 14. View southeast toward New Deal manganese mine on south slope of Owlshead Mountains. Avawatz Mountains in background.

in the limestone, but also in sandstone and volcanic breccia. These ore bodies are small and discontinuous but are exposed by workings scattered over a belt 3,000 feet long.

Open cuts have been excavated at intervals along the southwest slope of a northwest-trending ridge near the head of Whipple Wash. The most extensive workings are the farthest to the northwest. Here an open cut, roughly 20 feet square, has a 20-foot face into which a short adit ending in a circular stope has been driven. The stope, 6 to 10 feet high, is about 30 feet in diameter but has a pillar 10 feet in diameter in the center. The adit strikes N. 30° W. A smaller cut, partially filled, lies just below and to the southwest. Ore from these workings was hauled by tractor and trailer for about a mile to the end of the road from Cross Roads.

New Deal (Old Hole, Owls Head, Owls Hole) Mine. Location: sec. 16, T. 18 N., R. 3 E., S.B.M. (projected), on southeast slope of Owlshead Mountains and about one mile north of Owl Hole Spring. Owner: L. K. Orwig, 1079½ Leighton Avenue, Los Angeles, California.

The output of the New Deal mine, the most productive manganese property in San Bernardino County, is said to have totaled somewhat more than 15,000 tons of which about one-fifth, averaging 45 percent manganese, was mined in the period 1914-1918, and four-fifths, averaging 20 percent manganese, was mined in the period 1941-1946. An additional, though undetermined, tonnage was obtained in operations continuing to the fall of 1950 when the mine was shut down.

Most of the manganese of the New Deal mine area occurs in veins cutting the basal, conglomeratic member of a thick section of Tertiary non-marine strata.[117] The conglomerate, which is composed of poorly sorted rock fragments (granite with subordinate marble) in a sandy matrix, lies upon the pre-Tertiary crystalline rocks that form the core of the Owlshead Mountains. Locally, small manganese-bearing veins cut granite and marble in the bedrock.

Only the larger veins in the conglomerate appear to be of commercial significance. They consist of hematite and manganese oxides, principally pyrolusite and psilomelane, forming a matrix that surrounds granite and marble fragments and shows gradational contacts with the bordering conglomerate. The larger of the known bodies occurs in two areas, about one-third of a mile apart. One contains the "east workings"; the other contains the "main workings."

The east workings, which are the more recent and more extensive of the two, have developed a manganiferous lens about 150 feet in exposed length and 30 feet in maximum width. The lens trends northwest and seems to dip steeply to the southwest. The lens appears to have been first worked largely by underground gophering operations, remnants of which are now joined to an open cut about 70 feet long, 10 to 30 feet wide, and as much as 40 feet deep. A 40-foot vertical shaft in the floor of the pit bottoms in a barren breccia of granitic rock.

The "main workings," active mainly during World War I, have developed two nearly parallel, northwest-trending veins about 225 feet apart. Both dip moderately to the southwest. The larger and more northerly vein, as exposed in underground workings, ranges from a few inches

[117] Trask, P. D., and others, op. cit., pp. 203-205, 1950.

FIGURE 15. View southeast toward principal opening at Stewart manganese mine. Slickensided foot-wall is exposed at left in cut; hanging wall is gradational.

to as much as 4 feet thick, and exceeds 150 feet in maximum horizontal dimension. It has been followed down-dip to a vertical depth of 90 feet by an inclined shaft with levels at 20 and 65 feet and at the bottom. An adit connects with the shaft at the 20-foot level and follows the vein for 150 feet; this was the haulage level. At the 65-foot level a drift extends 60 feet to the northwest and 40 feet to the southeast. Ore was stoped between the 65-foot and 20-foot levels for a total length of about 60 feet. The drift on the bottom level is only a few feet long. These workings have followed the vein to points where it pinches out or could not be profitably worked. The other vein, which appears to be shorter and to have a narrower average width, has been followed for 75 feet by an adit no more than 15 feet below the surface.

During World War II a 35-ton mill was constructed at Owl Spring. The ore was broken to minus $\frac{3}{8}$ inch in a 10- by 12-inch jaw crusher and 12- by 26-inch rolls. It was ground to minus 48 mesh in a rod mill, concentrated on 4 tables, and sintered to a grade of 50 percent manganese.

Stewart Mine. Location: sec. 6, T. 3 N., R. 25 E., S.B.M., on the north slope of the Whipple Mountains about 6 airline miles southeast of West Well. Ownership: J. W. Stewart, Vidal, California, owns 12 claims.

The only serious effort to operate the Stewart manganese mine was made by the Mineral Materials Company of Alhambra during the period from August 1942 through September 1943 and resulted in the production of slightly more than 212 tons of ore.[118] This was shipped to the Metals Reserve depot at Parker, Arizona. An operation earlier in 1942 probably yielded less than 50 tons.

In the mine area fissure zones in fanglomerate are impregnated and cemented with black manganese oxides associated with brown calcite, probably manganiferous, and hematite and limonite. The principal deposit has a smooth slickensided footwall which strikes N. 10°-15° W. and dips 65°-70° west; the hanging wall is gradational. This ore zone was first developed along three levels, a surface cut and two short adits driven S. 10° E. within a vertical interval of about 50 feet. This is now one open cut 100 to 120 feet long and 2 to 10 feet wide. The floor of this cut is about 20 feet above the bottom of a small narrow canyon.

Workings on similar but less extensive bodies elsewhere on the property consist of short adits and one 18-foot inclined shaft with a short drift at the bottom.

The tenor of the ore is low, and hand sorting was required to bring the grade up to 35 percent manganese. According to Wilson[119] individual shipments made during the early part of 1943, ranged in grade from 35.84 to 39.66 percent manganese.

Mercury

Areas containing mercury minerals exist at only a few localities in San Bernardino County. Probably none are of commercial significance, although a negligible output of mercury was noted in California Division of Mines production reports for the years 1940 and 1941. The amount and source are unknown to the writers. Cinnabar occurrences that have been noted are listed in the accompanying tabulated index.

Molybdenum

Molybdenum minerals have been noted in the New York Mountains and Lytle Creek areas of San Bernardino County. Only the Big Hunch molybdenite deposit, at the south end of the New York Mountains, has been seriously developed. This operation is summarized in the accompanying tabulated index.

Rare-Earth Elements

Of major significance was the discovery in April 1949 of commercial concentrations of rare-earth minerals in San Bernardino County. The discoverers, Mr. Clarence Watkins and Mr. Herbert Woodward of Goodsprings, Nevada, were using a geiger counter while prospecting in the Mountain Pass area. At a locality about 1¼ miles north of U. S. Highway 91 and half a mile northwest of the Sulphide Queen gold mine, then idle, they detected radioactivity in veins containing abundant barite and calcite.

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[118] Mineral Materials Company, personal communication.
[119] Trask, P. D., and others, op. cit., p. 206, 1950.

FIGURE 16. View east toward camp and mill of Molybdenum Corporation of America at Mountain Pass. Mill is used to treat rare-earth ore from nearby Mountain Pass deposit. Old Sulphide Queen gold mine at upper left.

Specimens were submitted to Dr. D. F. Hewett of the U. S. Geological Survey and to Mr. E. T. Schenk of the U. S. Bureau of Mines, both of whom noted the presence of rare-earths. Hewett tentatively identified as a major constituent the mineral bastnäsite, a fluo-carbonate of the rare-earth elements cerium and lanthanum. The identification was later confirmed in the laboratories of the U. S. G. S. Also detected was at least one other rare-earth bearing mineral. The radioactivity was traced to a minor proportion of thorium, probably largely confined to the mineral monazite.

Shortly thereafter a party of other members of the U. S. Geological Survey began investigations of the discovery deposits known as the Birthday group. This program was later expanded to include a much larger area. Concurrent with these studies, prospectors found that other rare-earth bearing veins occurred in a 5-mile belt extending from the Birthday claims southward across Highway 91. By May of 1950, twenty or more of such veins were known. These findings, however noteworthy, were dwarfed when, in August 1951, U. S. Geological Survey personnel discovered an unusually large rare-earth bearing body on the Sulphide Queen property. This body, an irregular, elongate lens of barite-carbonate rock, has surface exposures covering about 20 acres. During later exploration it was found to be a lens dipping 30°-40° W. across the planar structure of the metamorphic rocks that border it.

Among the several mining companies whose attention has been attracted to the area, by far the most active has been the Molybdenum Corporation of America. Late in 1949 this company purchased the Birthday claims from Messrs. Watkins and Woodward. Subsequent exploration included the sinking of a 100-foot, vertical shaft from the bottom of which was driven a cross-cut intended to intersect the discovery vein. Disappointingly, the cross-cut encountered no minable concentrations of rare-earth minerals in passing beneath the outcrop of the vein.

In January 1951, when the company was considering its next move, the Survey announced the discovery of the large body on the Sulphide Queen property, then owned by Mr. F. B. Piehl and Mr. H. L. Martin. Soon afterward the Company purchased the Sulphide Queen claims and mine installations, and subsequently acquired ownership rights to other claims newly staked on the property. By early 1952 the Company had obtained additional claims covering veins as far as 3 miles to the south of the Sulphide Queen mine.

A drilling program covering much of the large deposit to a 50-foot depth, is reported to have outlined a 400-foot by 1000-foot block averaging 10 percent rare earths.[120] The entire deposit is believed to contain roughly one billion pounds of rare earths per 50 feet of depth. A reserve of several billion pounds is thought likely.

While exploration proceeded, several consulting firms were engaged to solve a concentration problem made difficult by the nearness of the specific gravities of barite and the rare-earth minerals. A milling technique was being developed in 1952 using flotation, tabling, filtering, and drying processes. Also a chemical plant was under construction to treat the concentrate and to produce a purer final product. Concentrates both of barite and of rare-earth oxides were to be produced.

[120] Anonymous, Southern California's rare-earth bonanza: Eng. and Min. Jour., vol. 153, no. 1, p. 102, Jan. 1952.

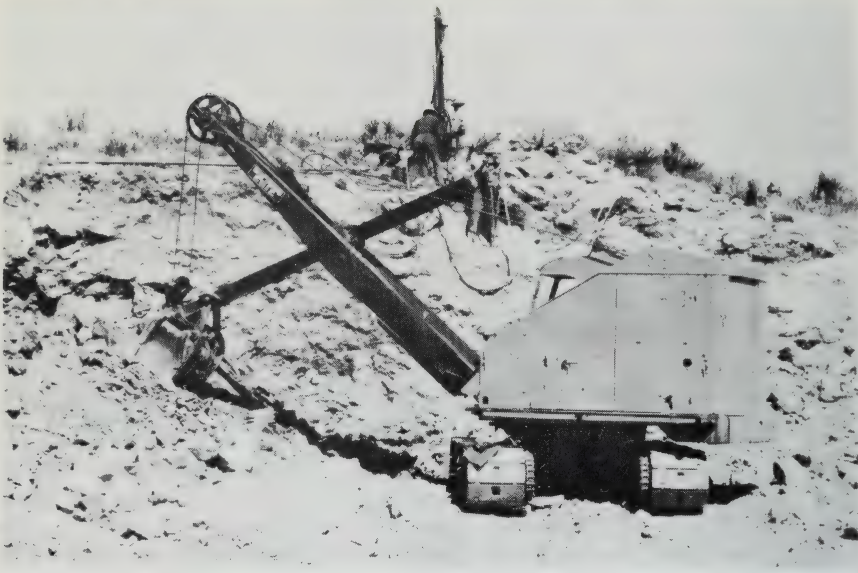

FIGURE 17. View east toward quarry in high-grade lens of rare-earth ore, at Mountain Pass mine of Molybdenum Corporation of America.

Other than the Mountain Pass mine holdings, several groups of claims cover adjoining ground along a southeast-trending belt several miles long extending south of U. S. Highway 91. Although some exploration work has been done on these claims, none have been put into operation. Included in this belt are the Bullsnake and Horseshoe groups east of the Mountain Pass mine north of the highway, and the Mineral Hill, Lucky Strike, Rathburn, Summit, and Windy Boy groups south of the highway.

The following description of the general geological features of the rare-earth bearing area was prepared by J. C. Olsen.[121]

The area of known rare-earth mineral occurrences is bounded on the east and south by the alluvium of Ivanpah Valley; on the west by the Clark Mountain fault, a westward-dipping normal fault along which, according to Hewett, the Paleozoic sediments and Mesozoic sediments and volcanic rocks on the hanging wall have been displaced as much as 12,000 feet relative to the pre-Cambrian rocks of the footwall; and on the north by a prominent cross-fault that cuts the Clark Mountain fault and is just a few hundred feet north of the Mocam shaft. The pre-Cambrian block that extends 10 miles north of this cross-fault is not known to contain any of the rare-earth mineral deposits of alkalic intrusives.

The pre-Cambrian metamorphic complex consists of hornblende and mica gneisses and schists, containing sillimanite or coarse garnet in some places, invaded by biotite granite gneiss with coarse rectangular or eye-shaped feldspar grains; by light-colored granitic augen gneiss and associated pegmatites; and by minor dike rocks of mafic to intermediate composition. All these pre-Cambrian rocks have a foliation that strikes about parallel to the general trend of the Clark Mountain fault and dips 50°-80° W. in most places. Units based upon the relative proportions of the various pre-Cambrian rock types have been recognized . . .

Potash-rich dike rocks intrude the foliated pre-Cambrian rocks and may be late Mesozoic, like certain other intrusive and extrusive rocks in the region, but their age

[121] Olsen, J. C., Preliminary report to accompany geologic map of the Mountain Pass district, San Bernardino County, California: U. S. Geol. Survey, open file report, 1952.

is uncertain. These potash-rich rocks range in composition, and generally decreasing age, from dark biotite shonkinite through several varieties of syenite to granite. They are cut by andesitic dikes that are probably Tertiary.

The biotite shonkinite is composed of potash feldspar and more than 50 percent dark minerals. The dark mineral is mostly biotite, but augite and hornblende are common; and aegirine and soda-amphiboles, such as riebeckite, indicate alkaline affinities.

The syenites range from rocks that are nearly all potash feldspar to some that are rich in biotite, hornblende, or augite, approaching shonkinite in composition. The granite contains potash feldspar and as much as 30 percent quartz, minor sodic plagioclase, and very little biotite or other dark minerals. The rocks intermediate in composition between shonkinite, syenite, and granite, together with the wide distribution of all the varieties throughout the district, suggest their derivation from a common magmatic source.

Of the seven larger intrusives, the two nearest U. S. Highway 91 are potash syenites, with two or three percent quartz; the southeasternmost is red granite; and the other four are composite shonkinite-syenite bodies. These intrusives appear to dip southwest at moderate to steep angles. The thinner dikes, mostly two to ten feet thick, are numbered in the hundreds, and they include types from shonkinite through syenite to granite. Relations between these dike rocks throughout the district clearly demonstrate the age sequence from shonkinite, the oldest, to the lighter-colored syenites, and then the granites, followed by a few dark dikes that are referred to as lamprophyre. The lamprophyre resembles shonkinite in composition, but it is mostly fine grained except for phenocrysts of biotite. The intrusion of these dike rocks was followed by shearing, by emplacement of the carbonate rocks and veins, and deposition of minerals along shear zones.

Carbonate rocks and veins are most abundant near the south and west margins of the large shonkinite-syenite body north of U. S. Highway 91, in both the intrusive and the adjacent pre-Cambrian gneiss. They are also found south of the highway, chiefly in areas where shonkinite, syenite, or granite dikes occur. The carbonate rocks are composed chiefly of calcite, dolomite, barite, and quartz. Bastnasite has been found in many of them, from the original discovery near the Mocam shaft near the north end of the district, as far south as the Windy prospects. Abnormal radioactivity found in prospects about a mile southeast of the Windy prospects indicates that the same type of mineralization extends to the southeast corner of the mapped area.

Most of the carbonate-barite-quartz veins shown on the map are one to six feet thick. They cut across the pre-Cambrian foliation and all the potash-rich dike rocks. Some appear to have been emplaced in fractures in the shonkinite-syenite intrusives. The large barite-carbonate mass near the Sulphide Queen mine is similar in general composition to the thinner veins, containing several carbonate minerals, chiefly calcite and dolomite; barite; the fluo-carbonates bastnasite and parisite; quartz; crocidolite; biotite; apatite; monazite; galena; magnetite; fluorite; and other minerals. The carbonate rock in this large mass is foliated, locally contains breccia fragments of several types of older rock, and is discordant to the pre-Cambrian structure. These features, together with the wide distribution of the carbonate veins and their close association with the potash-rich dike rocks in the district, suggest that the materials forming the carbonate rocks were probably derived largely from the same magmatic source that supplied the alkalic dike rocks; but the nature of the fluids transporting the rare constituents is not yet understood.

Dikes, chiefly of andesite, and a few of felsite (rhyolite?), cut across the potash-rich dikes and the carbonate rocks. The andesitic dikes occur in swarms in four principal areas in the district and appear to have been emplaced in fractures formed distinctly later than the alkalic dike rocks and carbonate rocks. In general, the andesitic dikes have an easterly trend in contrast to the northwesterly trend of the alkalic dikes.

Unconsolidated gravels and alluvium, derived from rocks within the district, from Clark Mountain, and from the Mescal Range, have accumulated to considerable thickness near Mountain Pass and U. S. Highway 91. Ridges with several hundred feet of relief have been formed by the dissection of these unconsolidated materials. The gravels probably obscure some rare-earth mineral deposits."

Silver

Most of the silver now produced in San Bernardino County is obtained from ores mined primarily for lead and zinc. However, in two districts, Calico and Randsburg, and at several scattered mines, exist

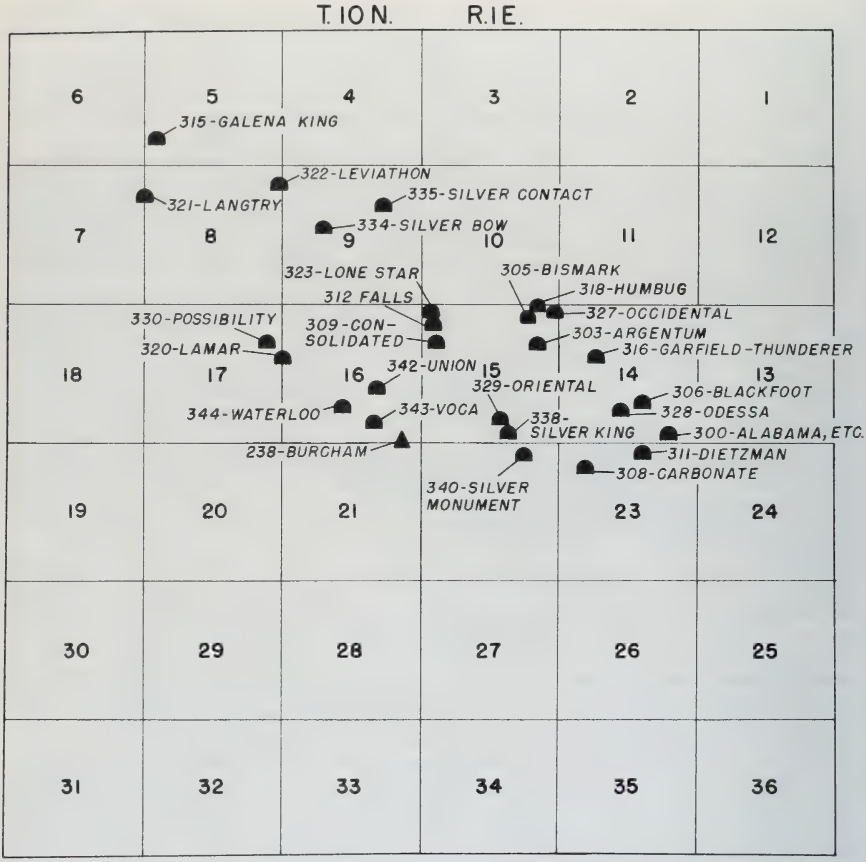

FIGURE 18. Plat of Township 10 North, Range 1 East, showing location of principal mines in the Calico district.

deposits in which silver is the only significant metal. The deposits near Randsburg and Calico, described below, have been the outstanding sources of silver in California, but are now generally inactive.

Only when these deposits were most active, 1883-88 for Calico, and 1920-25 for Randsburg, did the annual silver output of San Bernardino County exceed $1,000,000. The annual output has not exceeded $100,000 since 1941; in 1950 it had declined to less than $12,000 or about 0.03 percent of the county's total mineral production.

Calico District

One of the most productive and colorful groups of mines in California is in the Calico district about 10 miles northeast of Barstow. During the period 1882-1896 these mines yielded silver ore with a total value estimated variously at 13 to 20 million dollars.[122] Rich silver ore was dis-

[122] Silver production statistics for San Bernardino County, last compiled by Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, plate 5, 1943, show, for the period 1880-1900, an output valued at slightly less than $14,000,000. Other reports, including Erwin, H. D., and Gardner, D. L., Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California: California Div. Mines Rept. 36, pp. 293-304, 1940, cite a $20,000,000 figure.

covered in 1881; most of the larger deposits of the district were opened in the following year. The first output was hauled 40 miles to Oro Grande, but mills were soon installed at Calico and Daggett.

Following the bonanza operations of the first few years, mining activity was strongly influenced by fluctuations in the price of silver. In the period 1883-85 San Bernardino County yielded nearly 6 million dollars in silver, about 85 percent of the state's total, and obtained mostly from the Calico district. In 1890, at the peak of activity, mills totaling 150 stamps were treating the ores, and about 700 men were employed in the mines and mills. The monthly output of bullion was valued at about $200,000. By 1892, however, diminishing production forced the closing of two mills, one with 60 stamps, the other with 15 stamps, both at Daggett. A 30-stamp mill owned by the Silver King Mining Company remained in operation at Calico until 1896.

The drop in the price of silver from $1.13 per ounce in 1894 to 57 cents in 1896, together with the exhaustion of the known high-grade bodies, led to virtual cessation of mining. Several factors, including the richness of the ores, the belief that the bodies were shallow, and the unrestricted activities of lessees, led to improper mining practices at many of the properties. The leasing was of the type commonly known as "chloriding" in which only high-grade ores are sought and methods are unsystematic. Ore mined by lessees was treated at a custom mill, the claim owner receiving one-sixth to one-fourth of the return.

Since 1896 the district's operations have been done mostly by lessees, and have been intermittent and on a small scale. In 1920 the Zenda Company started a deep exploration program in the Silver King-Oriental properties, but this and similar projects at several other properties have produced very little ore. The falling price of silver in 1932 discouraged further exploration of the district, although the Burcham mine, a gold property, continued active until 1941. Operations in the district were very minor in 1952. Of interest, however, is a current project aimed at restoration of the old townsite of Calico as a "ghost town" of historical interest to tourists.

The Calico Mountains, which contain the Calico silver mines, are composed essentially of volcanic rocks and lake deposits, both of Tertiary age.[123] which rest upon a crystalline pre-Tertiary basement, unexposed in the silver-bearing areas. The Tertiary is broadly divisible into three units. The lower part, 3000 to 4000 feet thick and probably of Miocene age, is composed of massive tuff, tuff breccia, agglomerate, rhyolite, dacite, and andesite. Resting conformably upon the lower unit is a 1300-foot thickness of lake beds, with a subordinate fraction of volcanic rocks. It includes shale, sandstone, cherts, travertine, tuff, as well as the Calico borax deposits noted in a section to follow. This middle unit, believed to be of upper Miocene age, is, in turn, overlain with marked unconformity by Pliocene (?) andesite 200 to 500 feet thick. The Miocene rocks are moderately deformed.

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[123] Geologic data in this section were obtained from the following references: De Leen, J. L., Geology of the Calico mining district, unpublished thesis, University of California, 1950; Erwin, H. D., and Gardner, D. L., Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California: California Div. Mines Rept. 36, pp. 293-304, 1940; Lindgren, Waldemar, The silver mines of Calico, California: Am. Inst. Min. Eng. Trans., vol. 15, pp. 717-734, 1887; Storms, W. H., San Bernardino County: California Mining Bur., Rept. 11, pp. 337-345, 1893.

The silver deposits exist in various sedimentary and volcanic members of the Miocene units, and are associated with tensional faults. The deposits are roughly divisible into two types: (1) those lying within or near prominent faults or fractures, and (2) those occurring as shallow, pockety disseminations.

Both types are characteristically shallow, although the veins, which are composed mostly of barite, commonly do continue below the known silver mineralization. The deepest workings are 550 feet beneath the surface; few mines exceed 200 feet in depth. Deep exploration has been hampered by water flowage, and the swelling of tuffs when exposed to water.

The silver-bearing veins consist chiefly of chlorides and chlorobromides of silver in a gangue of barite and jaspery silica. Coatings of cerargyrite and embolite are abundant. Also present are galena, sphalerite, minor proportions of chalcopyrite, and traces of gold. Barite commonly forms as much as 95 percent of the vein material.

The average value of the Calico ores was 10 to 20 ounces of silver per ton, but high-grade pockets of cerargyrite or native silver yielded ore valued at as much as $2000 per ton.[124] Ore valued below $30 a ton was considered low-grade.[125]

The mines of the Calico district[126] are disposed within an area about 5 miles long by 2 miles wide that trends northwestward. Larger mines are confined to three areas within the belt. The central group, lying within a mile northwest of the Calico townsite, includes the Silver King-Oriental and Falls (Sioux) mines in the vicinity of Wall Street Canyon. The east group, northeast of the townsite, includes the mines of the Calico-Odessa group in the vicinity of Bismarck and Odessa Canyons. The west group contains the Burcham, Langtry, Union, and Waterloo properties.

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[124] De Leen, J. L., op. cit.

[125] Lindgren, Waldemar, op. cit., p. 730.

[126] The following descriptions of the history, geology, and mines of the Calico district are largely summaries of information obtained from the following references:

Cloudman, H. E., Huguenin, E., and Merrill, F. J. H., San Bernardino County: California Min. Bur. Rept. 15, pp. 823-826, 1919.

Crawford, J. J., Mines and mining products of California: California Min. Bur. Rept. 12, p. 376, 1894.

Crawford, J. J., Thirteenth Report of the State Mineralogist (third biennial), for two years ending Sept. 15, 1896: California Min. Bur. Rept. 13, pp. 606-609, 1896.

De Groot, H., San Bernardino County—its mountains, plains, and valleys: California Min. Bur. Rept. 10, pp. 530-531, 1890.

De Leen, J. L., Geology of the Calico mining district: unpublished thesis, University of California, 1950.

Erwin, H. D., and Gardner, D. L., Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California: California Div. Mines Rept. 36, pp. 293-304, 1940.

Goodyear, W. A., San Bernardino County: California Min. Bur. Rept. 8, pp. 504-511, 1888.

Irelan, William, California Min. Bur. Rept. 8, San Bernardino County, pp. 491-499, 1888.

Lindgren, Waldemar, The silver mines of Calico, California: Am. Inst. Min. Eng. Trans., vol. 15, pp. 717-734, 1887.

Storms, W. H., San Bernardino County: California Min. Bur. Rept. 11, pp. 337-348, 1893.

Tucker, W. B., Los Angeles field division, San Bernardino County: California Min. Bur. Rept. 17, pp. 362-365, 1921.

Tucker, W. B., and Sampson, R. J., Los Angeles field division, San Bernardino County: California Div. Mines Rept. 26, pp. 271-291, 1930.

Tucker, W. B., and Sampson, R. J., San Bernardino County: California Div. Mines Rept. 27, pp. 343-345, 1931.

Tucker, W. B., and Sampson, R. J., Current mining activity in southern California: California Div. Mines Rept. 36, pp. 33-82, 1940.

Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, pp. 475-492, 1943.

Central Group. The Silver King mine, just north of the Calico townsite, was one of the first and most productive operations in the district and had probably the longest and most successful operating history. Several other mines, adjacent to the Silver King and on the Kings vein system, were operated with it as a group by the Silver King Mining Company. One of the most significant of these was the Oriental mine; the two have been commonly referred to collectively under the name Silver King and Oriental. Other claims in the group include the Wall Street, Red Cloud, Oregon, Josephine, and Burning Moscow. A total of 35 claims were held in 1931.

The two main veins in the Kings vein system, the Oriental and Silver King, strike northwest and dip from vertical to 70° SW. The system, which is traceable for 2 miles on the surface, branches to the north and converges into a mass of crushed and mineralized rock to the southeast. In general, the veins range from 2 inches to 2 feet wide, and have well defined walls. At the southeast end of the system intensive brecciation obscures the limits of the veins. The ore persistently consists of chlorides and chlorobromides of silver in a gangue of barite and jaspery silica. Cerargyrite and embolite occur mostly as thin coatings in cracks and joints, but also are disseminated in barite. Manganese oxides are common. High grade lenses of almost solid cerargyrite valued at thousands of dollars per ton were not uncommon. The value of ore was invariably found to decrease with depth, although the barren vein continued downward. In the deep development workings the veins were found to contain chalcopyrite, tetrahedrite and pyrite.

Mine workings are very extensive. The three principal workings on the mineralized zone, the Silver King, Oriental, and Red Cloud mines, are connected at numerous places. The veins were originally worked through an inclined shaft 500 feet deep. A series of crosscut tunnels on the 4th, 6th 7th, 8th, and 9th levels connected with the Oriental mine workings. About 6000 feet of drifts and cross-cuts completed the workings during this stage. In 1926 the Zenda Gold Mining Company acquired the property and completed 815 feet of diamond drill exploration. In the operation that followed, two vertical shafts were sunk about 550 feet apart, and 340 and 530 feet deep; level work was brought to a total of at least 12,000 feet.

First opened in 1881, the Silver King and Oriental group operated continuously until 1893 when silver fell to 78 cents an ounce. During the four years 1883 to 1886 the mine yielded 37,000 tons of ore with a gross value of $1,355,000 or $36.61 per ton in silver. As recently as 1931, when the property was held by the Zenda Company, 47 men were employed. The latest production from the mine was in 1930 when two carloads of ore valued at $15,000 were shipped. From 1936 to 1941 a moderate quantity of silver was produced from remilling old tailings. In 1950 four claims of the Zenda holdings that included the old Calico townsite, were sold to the owners of Knott's Berry Farm, a restaurant in Buena Park, California. Calico is currently being restored as a historical attraction. Water is pumped from the deep shaft, now flooded to the 320 level, for this venture. No mining is contemplated.

On the west side of upper Wall Street canyon is a group of workings lying along a northwest extension of the fault system at the Silver King mine. The area is underlain mainly by andesite and acidic agglomerate

tuff and flows. These rocks are cut by mineralized fissures striking N. 25° W. and dipping 75° to 85° NE. The veins contain barite and jasper abundantly stained with iron oxides. The veins are closely spaced and free of breccia.

The Falls mine appears to have been the most extensively worked in this area; remnants of a mill remain on the property. The mine workings, high on the precipitous west wall of the canyon, are mostly confined to a zone about 100 yards wide and one-quarter of a mile long. They consist of various open stopes, shafts, and adits, and have exposed four or five veins. The easternmost vein has been extensively mined for over 500 feet of its exposed length and to depths of 300 feet.

The Consolidated (formerly St. Louis) mine, southeast of the Falls mine, has a similar geologic setting. The property is developed by about 500 feet of workings which follow six closely spaced veins.

East Group. The Calico-Odessa group consists of numerous mines rather widely distributed in an area about 2 miles northeast of Calico, mainly between Bismarck and Garfield Canyons. Included are mines formerly belonging to the Odessa group (Dragon, Dunderberg, Gobbler, Little Jane, and Odessa) and the Occidental group (Argonaut, Bismarck, Boss, Cleveland, Garfield, Invincible, Occidental, Runover, Thunderer and Veto) as well as other properties such as the Baltic, Blackfoot and Humbug. From time to time the mines now comprising the Calico-Odessa group have been organized differently. Consolidation followed the period of maximum activity.

The deposits developed by the Odessa mine are on the west wall of Garfield Canyon. Like those at the nearby Garfield-Thunderer mine, they exist in rhyolite tuff as impregnations along a zone of porous rock. The deposits are richest where the zone is cut by several faults which trend northwest and dip moderately to steeply southwest. The ore occurred in irregular pockets some of which were unusually large. The ore minerals include chlorides and chlorobromides of silver and traces of malachite and chrysocolla. The average grade of the ore was probably the highest of any silver mine in the Calico district, but it was removed rapidly and unsystematically. The mine was idle by 1896. The Odessa workings include a main tunnel driven 600 feet northwest along the main fault, two lower tunnels 150 and 200 feet long, and several inclined winzes as much as 100 feet long.

The Garfield or Garfield-Thunderer mine is on the west slope of Garfield Canyon. The Garfield claims are bordered on the west by the Thunderer and Veto properties which are, in turn, bordered on the west by the Occidental property. All are commonly referred to under the collective name "Garfield-Thunderer group." The ore bodies occur in massive rhyolitic tuff and lie near the Garfield fault which strikes west-northwest, dips steeply south, and extends westward to the Occidental and Humbug properties. A few ore bodies were found along the fault but most formed south of the fault in breccia zones and numberless, irregular fissures. The bodies are very irregular and as much as 40 feet wide. They contain cerargyrite, embolite, and minor chrysocolla in a barite gangue.

The mine was opened by short adits driven from the canyon wall. Later, two tunnels, one 100 feet above the other, were driven along the fault; the lower tunnel is 4,000 feet long, the upper tunnel is 2,500 feet long. Much of the ore was mined from two chambers, 200 and 300 feet long, 40 feet

wide, one in each tunnel. The lower tunnel cuts through the Cleveland, Garfield, Occidental No. 1, Runover, Thunderer, and Veto mines. No timber was required.

The Garfield mine was opened in December 1882; by the following April, two men had produced 11 tons of ore which yielded $5,885. Six men employed in the month of July shipped 33 tons of ore that yielded $26,440, and 233 tons that yielded $30,756. In September, 96 tons yielded $8,736 and nine tons yielded $7,200, or about 800 ounces per ton. The output from November 1883 through 1884 included 2400 tons of ore that yielded $290,400, as well as other ore not recorded. The mine was still active in 1896.

The Bismarck and Humbug mines are on a divide between the head of Bismarck Canyon and a branch of Wall Street Canyon. Here silver minerals occur along a major fault zone which strikes N. 17° W., and dips about 30° W. The zone, which can be traced to the southeast for at least a mile, separates andesite on the hanging wall from sandy tuff on the footwall.

The Bismarck ore bodies occur along a well striated plane in the fault zone. The ore was mined from shallow, irregular barite-rich masses eight inches or less wide. The Humbug workings lie about 20 to 30 feet to the east. Here silver minerals were found in barite-free disseminations at depths of less than 30 feet. On both properties cerargyrite is the principal ore mineral and is accompanied by a minor proportion of chrysocolla.

Several inclined shafts and irregular stopes, no more than 100 feet in maximum depth, comprise the Bismarck workings. The Humbug deposit was mined mainly by an open pit 30 feet or less deep. These mines have probably not been in operation since 1892.

The Blackfoot mine is on the east side of Garfield Canyon about half a mile southeast of the Garfield mine in an area underlain by andesite. The ore bodies exist as shallow deposits along a fault that strikes west-northwest and dips about 50° to 75° NW. The ore minerals are cerargyrite and subordinate lead carbonate in a jasper gangue. Ore shoots, mostly in the hanging wall of the fault, were generally six to 10 inches wide, and 300 to 400 feet long. Ore also existed as stringers in the hanging wall. Although the fissure was explored below the ore bodies, only barren jasper gangue was found at depths greater than 75 feet.

Southwest of the vein are three groups of irregular zones in which silver minerals impregnate rhyolitic tuff. The deposits follow gently dipping bedding planes in the tuff and have no apparent relation to the fissures. Chloride minerals were formed in seams and streaks in the tuff but did not continue in economic concentrations deeper than 30 feet below the surface.

West Group. The Langtry, the westernmost of the Calico mines, is in the lake sediments low on the range front about 3 miles northwest of Calico. The country rock, a sequence of nearly horizontal mud shales and argillaceous sandstones, is cut by the silver-bearing veins. This property, never an important producer, is notable because its ore bodies, unlike the others of the Calico district, are simple fissures in rock that shows little brecciation or fracturing. Two veins, 60 feet apart at the surface, strike northwest, and dip steeply toward each other. Their width ranges from a fraction of an inch to more than 10 feet on the north vein, and averages 3 or 4 feet. The veins are filled chiefly with coarsely crystallized barite

with quartz, containing iron and manganese oxides, lead carbonate and silver chlorides. The ore is reported to have averaged from 6 to 22 ounces of silver per ton.[127] Development work consists of about 250 feet of workings, including a 50-foot winze, from which about 200 tons of ore has been mined.

The Waterloo mine is the largest of the group that lies about one mile west of Calico. During its most active period the mine supplied two stamp mills operated in Daggett by the mine owners. The Waterloo was opened in 1881, was most productive in the 1880's and was being operated on a small scale in 1896.

The ore bodies lie along a fault zone separating lake beds and volcanic rocks. The zone strikes westward to northwestward, and dips moderately north. The mineralized zone has been followed laterally for about 1100 feet, down-dip for about 525 feet, and through thicknesses that range from 4 feet at the east end to as much as 70 feet at the west end. The ore bodies were irregular masses composed of chlorides and chlorobromides of silver in a barite-jasper gangue. The ore is reported to have averaged from 11 to 20 ounces of silver per ton, but some shipments assayed as high as 1000 ounces.

The Waterloo mine workings total about 10,000 feet in length. These center about a 350-foot shaft with 7 levels at 50-foot intervals. The level workings consist mostly of drifts. In 1950 work had begun on a 540-foot extension of the 7th level intended to intersect a downward extension of the principal vein at the Union mine nearby.

The Voca mine is adjacent to and east of the Waterloo. It is in line with the strike of the Waterloo vein, but the workings have not encountered an extension of this vein. Unlike most of the ore bodies of the district, those at the Voca mine have a siliceous gangue; barite is comparatively rare. Most of the mining was done before 1888. During much of its active period the mine daily yielded 10 to 15 tons of ore averaging 40 ounces of silver per ton, but the total output was small.

Northwest of the Waterloo along the same zone are the Prosperity (Possibility) and Lamar workings. These are in lake beds which here strike north 30° W. and dip 15° NE. Workings are chiefly short adits and irregular stopes along a fault zone several hundred feet wide, and half a mile long. The workings are all near the surface, and in the clays and shales. A vertical range of possibly 200 feet exists between the uppermost and lowermost workings.

The Union mine is a small operation about one mile west of Calico townsite and immediately north of the Waterloo mine. It consists of workings driven along a vein in a fault zone separating rhyolite breccia and lake beds. The vein is 6 to 30 feet wide, strikes north 50° W., and dips 50° NW., but flattens with depth. Silver and lead minerals are irregularly distributed in the breccia and are accompanied by a gangue of barite and subordinate quartz. Development totals about 1000 feet of workings, including a crosscut driven 400 feet to the vein, 2 winzes sunk 100 feet on the vein, and limited drifting. Exploration work was done as late as 1940.

The Burcham mine, also known as the Total Wreck, is about one mile west of Calico townsite. It is the only mine in the district to yield gold in appreciable quantity. It was developed several years after the peak of

[127] De Leen, J. L., Geology and mineral deposits of the Calico mining district, thesis for Mining Engineer, University of California, 1950, and Storms, W. H., San Bernardino County: California Min. Bur. Rept. 11, p. 343, 1893.

the bonanza period of Calico's history, and was worked at intervals until 1941.

The mine area is underlain by flat-lying shales and shaly sandstones and by rhyolite tuffs, flows, and tuff-breccias. The area is traversed by a northwest-trending fault which dips 40° to 80° northeast and has thrust the volcanic rocks southwestward over the shales and sandstones.

The ore bodies occur in two veins, the Burcham and the Mulcahy, which cut the volcanic rocks and are, in turn, truncated by the thrust fault. The Burcham vein strikes N. 70° W. and dips 65° SW. The Mulcahy, exposed 300 to 500 feet to the north, strikes N. 45° W. and dips 65° S., and is believed to be an eastward extension of the principal vein at the Union mine.

The Burcham vein ranges from 3 to 10 feet wide. The gold is finely divided and is disseminated in quartz. Small, irregularly distributed high grade pockets of galena and sphalerite, and of silver chloride are also present.

The Mulcahy ranges from 4 to 30 feet wide. Its ore probably averaged about $6.50 per ton in gold and silver. A substantial tonnage of ore with an average value of about $15 per ton was obtained from a zone, 26 inches wide, along the footwall.

The underground workings on the two veins total about 10,000 feet in length, and explore each vein laterally for about 850 feet. A 512-foot northeast-trending crosscut intersects the Burcham vein at 104 feet and the Mulcahy vein at 410 feet.

Randsburg District

Most of the silver mined in the Randsburg district has been obtained from a closely spaced group of veins underlying a small area within San Bernardino County and within the limits of a settlement previously named Osdick, now known as Red Mountain. The gold deposits of the district lie mainly to the east, in Kern County.

The Kelly or California Rand mine which was opened in 1919 and has a recorded output valued at about 16 million dollars, has been the largest single source of silver in San Bernardino County and in California as well. During several of the Kelly's most active years, its silver yield was the largest of any domestic mine. The Kelly workings are confined to claims covering a northeast-trending area about 4500 feet long and 1200 to 1800 feet wide.

Ore of shipping grade also was encountered in the Coyote mine, bordering the Kelly on the southeast, and in the Santa Fe mine, bordering the Kelly on the northeast. In the Red Mountain area, numerous other workings, some quite extensive, were driven in unsuccessful attempts to encounter extensions of the high-grade mineralization. These include the Big Four, Flat Tire, Fox Lease, Kelly Rand Extension, Navajo and Swastika and Silver Bell.

The silver mines and virtually all of the silver prospects in the Randsburg district are confined to an area about 2 miles long in a northeasterly direction and about $1\frac{1}{4}$ mile wide. The Rand schist, an Archean formation composed mostly of biotite schist, amphibole schist, and quartzite, and which is extensively exposed in the north part of the Rand Mountains, underlies the west central part of the area noted above.[128] In the north-

[128] The geologic data in this section were obtained in personal communication with Mr. Frank Royer and from the following reference: Hulin, C. D., Geology and ore deposits of the Randsburg quadrangle: California Min. Bur. Bull. 95, 152 pp., 1925.

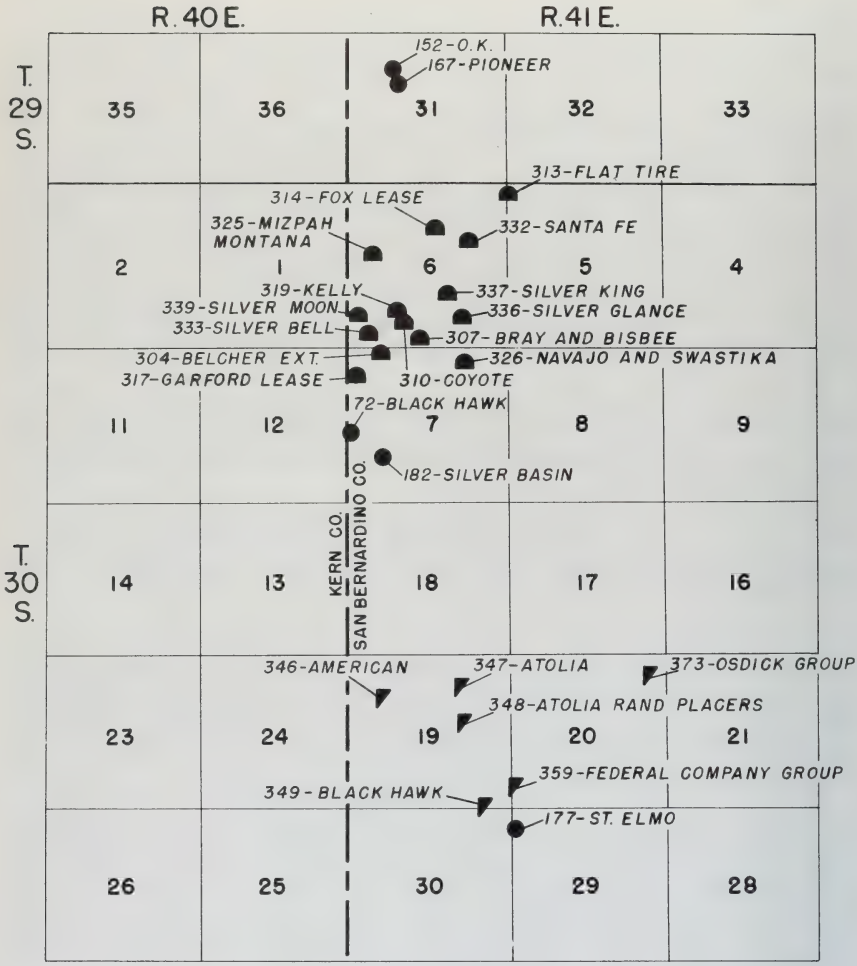

FIGURE 19a. Map of the Red Mountain area, showing the location of the principal mine workings that lie within San Bernardino County.

ern and southern parts of the area the Rand schist is intruded by bodies of the Mesozoic Atolia quartz monzonite. To the north and east of Red Mountain settlement, and lying on bedrock of the pre-Tertiary units, are continental sediments and acidic volcanic intrusive rocks, formerly believed to be Miocene in age, now known to be Pliocene.[129]

Although silver mineralization has been noted in the quartz monzonite and Pliocene rocks, all of the known silver deposits of commercial interest are in the Rand schist. The ore bodies exist in well defined but irregular veins, broadly divisible into two sets; an earlier set striking about N. 40° E., and a later set striking northward to north-northwestward. Most of the veins of both sets dips eastward or southeastward. In general the dips lessen with depth, averaging about 75° near the surface and 40° or less

[129] Hewett, D. F., personal communication.

at depths greater than 800 feet. Only a small proportion of the veins crop out; most terminate upward against a pre-mineral fault within the schist and dipping gently to the southeast. This fault is known as the "mud wall".

The northeast-trending set contains the most extensive veins. The largest of these, the Footwall vein, is exposed on the surface for a lateral distance of more than 3500 feet, and, for most of its length, ranges in thickness from 40 to 80 feet. The Shaft, Antimony, and Williams veins parallel the Footwall vein, and, near the surface, lie at average distances of 150, 300 and 1000 feet respectively, southeast of the Footwall vein. Within 400 additional feet, still farther southeast, are the Williams vein, Flat vein, and Coyote East vein.

The veins of the north-trending set commonly terminate against veins of the earlier set, and, therefore, are relatively short. These veins are generally from 5 to 10 feet thick, a somewhat narrower average than most of the northeast-trending veins. Sixteen of the north-trending veins have been named; several others are known. In general, the main north-trending veins are spaced at intervals of 200 to 500 feet, but branching is characteristic. Among the principal north-trending veins are the Blanck, Sill, Harrell, Nosser, Grady Lease and Wark.

All of the veins contain a siliceous gangue composed mostly of fine-grained quartz and chalcedony, and containing small proportions of opal (?), allophane, and calcite. The principal silver-bearing minerals are miargyrite, stylotypite or freibergite, and cerargyrite; present in small proportions are pyargyrite, and proustite. Pyrite and arsenopyrite are abundant in the northeast-trending veins, but much less so in the north-trending veins. Chalcopyrite and native gold are present but rare.

Some of the veins are in sharp contact with the wall rock, but most have gradational borders. The internal structure of the veins is characterized by a delicate banding in the gangue, by drusy cavities, and by angular inclusions of schist and quartz. Many of the veins have been crushed and brecciated.

The ore bodies occur as lenticular to pipelike shoots from a few inches to 60 feet wide and as much as 300 feet long. In general the best ores lie along the north-trending veins and are richest at the junctions of these with the northeast veins. Much of the ore consists of schist and pyrite- and arsenopyrite-bearing quartz, brecciated and cemented with silver minerals. The largest of the rich ore bodies were found to contain 25,000 to 50,000 tons of ore with average values of $70 to $100 per ton. With depth the mineralization appears to decrease in silver and increase in gold.

Kelly (California Rand) Mine.[130] Location: sec. 6, T. 30 S., R. 41 E., M.D.M., in town of Red Mountain and west of U. S. Highway 395. Ownership: Frank Royer, Red Mountain, California, owns 11 unpatented claims known as the Kelly Mine group, and covering about 148 acres.

The claims that comprise the Kelly property cover the Footwall, Shaft, and Antimony veins (see section on geology, above) for a lateral distance of about 4500 feet, and also cover most of the known north-trending veins. The mine has been worked mainly through 3 shafts: the

[130] The data in this section were obtained largely in personal communication with Frank Royer, owner of the Kelly mine, and from the following reference: Hulin, C. D., Geology and ore deposits of the Randsburg quadrangle: California Div. Mines Bull. 95, 152 pp., 1925.

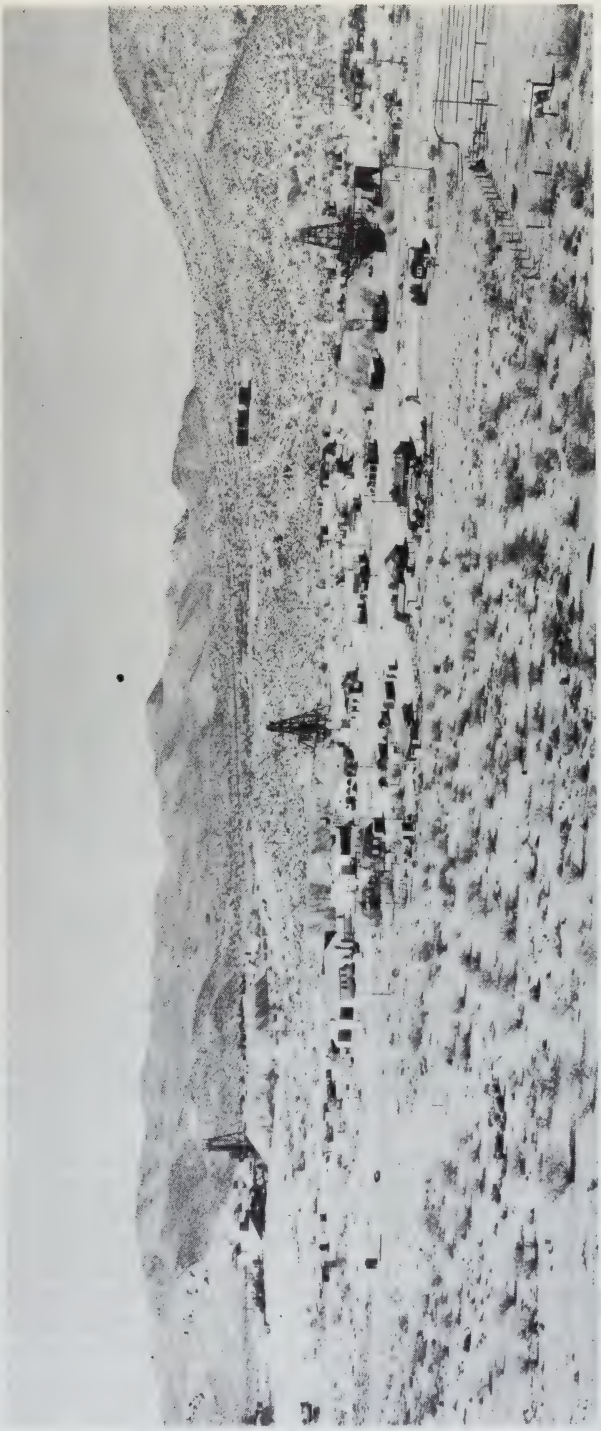

FIGURE 19b. View southwest toward silver mines at Red Mountain, showing Kelly No. 2 shaft (left), Kelly No. 6 shaft (center), and Santa Fe shaft (right). Hills in background and area in mid-foreground underlain by Rand schist (Archean). Hill at extreme right underlain mostly by rhyolite-latite intrusive body (Tertiary). Sandstone (Tertiary) is poorly exposed in foreground. Exposures of Footwall vein at extreme left extend upward and southward from behind Kelly No. 2 shaft.

No. 1 shaft, inclined 73° on the shaft vein, and 660 feet in vertical depth; and the No. 2 and No. 6 shafts sunk vertically to depths of 1660 and 900 feet respectively. These are joined, at various levels, to drifts and cross-cuts totaling more than 9 miles in length.[131] In general, the levels are spaced 100 feet apart. In mid-1952 the lowest 200 feet of the No. 2 shaft was water-filled.

The most extensive and productive workings lie along the Shaft and Antimony veins at or near their intersections with the Harrell and Nosser north-trending veins. The production from the Harrell-Antimony and Harrell-Shaft intersections alone has been valued at $12,000,000.

The discovery, leading to the development of the famous Kelly or California Rand silver mine, was made by Jack Nosser and Hamp Williams on April 12, 1919. These men had been planting claim corners for J. W. Kelly, then sheriff of Kern County, and were resting in the shade of a bold outcrop. Williams believed he recognized horn silver in the outcrop and samples were brought to Kelly who confirmed the identification through a Bakersfield assayer. The samples were found to contain $300 of silver and 3 ounces of gold per ton.

Ten claims, called the Uranium group, were located, and another claim, the Juanita, was purchased. Kelly quickly organized a group composed largely of Kern County officials and known as the California Rand Silver Mining Company. By mid-May 1919, the No. 1 shaft was begun on the discovery vein, later to be known as the Shaft vein. Ore was removed at first from a glory hole at the shaft and later from drifts joined to the shaft. The gross value of the first 7 months production was $285,831. In 1920 the workings at the No. 1 shaft were extended and yielded ore with a gross value of $1,086,916. In the meantime several lessees were active on various parts of the property. The Grady, held jointly by E. T. Grady and Edith Coons, was the first successful lease. It comprised a block 120 feet square, 450 feet deep and about 300 feet southeast of the No. 1 shaft. A vertical shaft encountered the ''mud wall'' (see geologic description above) at 190 feet and high-grade ore on the Grady Lease vein at 270 feet. Later it was found that a smooth wall which had bordered the shaft for 80 feet was actually an unpenetrated wall of the Grady Lease vein. The Harrell and Grady West veins were subsequently encountered. In the 14-month period, ending February 1, 1922, the Grady lease yielded 18,245 tons of ore valued at $1,613,074.

In 1921 the No. 2 shaft was started and put into operation. This shaft was sunk vertically from a point about 400 feet east-southeast of the No. 1 shaft, and was joined to it by several cross-cuts. In 1921 also, a cross-cut driven southwestward from the 4th level (200 feet vertical from the collar of the No. 1 shaft) encountered high-grade ore bodies on the Antimony, Harrell and Grady Lease veins. By the end of the year a flotation mill had been constructed on the property. The 1921 output of the mine, including the Company and Grady operations, was valued at $3,298,561.

The first concentrates were shipped early in 1922, and after July 1, 1923 all but a small part of the ore was milled on the property. By 1923 the No. 1 shaft had followed the shaft vein to a depth of 660 feet, and the No. 2 shaft had been sunk to a depth of 1003 feet.

In 1924 a body of high-grade ore was encountered near the intersection of the Antimony and Nosser veins. This was mined mostly in 1924 and

[131] Tucker, W. B., and Sampson, R. J., San Bernardino County: California Div. Mines Rept. 26, p. 273, 1930.

1925 in what came to be known as the "Million Dollar Stope." In this period also ore was mined from the Williams vein. By 1924 the No. 2 shaft had been completed to a depth of 1600 feet. From the 19th level (1440 feet below the collar) a tunnel was driven southeastward 1810 feet to encounter the Antimony vein, the Williams vein and a new vein.

Production continued high in the period 1926-28. The No. 6 shaft, about 1600 feet northeast of the No. 2 shaft, had been sunk vertically to a depth of 900 feet. Levels from the No. 6 shaft, which connected with workings of the Santa Fe mine to the northeast and with the No. 2 shaft, encountered substantial quantities of high-grade ore. But by 1929 ore was low in reserve and was becoming harder to find. Work centered on the 19th level of the Williams vein where high-grade gold ore had been found. Because stoping from this point was to be done 1800 feet from the shaft, the only point of exit, a State Mine Inspector ordered the work discontinued.

Discouraged by the expense of opening another exit, and by the drop in the price of silver from about $1.00 per ounce in 1923 to as low as 28 cents per ounce in 1929, the owners, in the fall of 1929, sold the mine to the Consolidated Metals Company. Eight months later the property was acquired by the Wortley Consolidated Mining Company, but early in 1931 it reverted to the Consolidated Metals Company when payments were not met.

In July 1931 the mine was purchased by H. L. Gibson and L. W. Main. In August 1933 it passed into the hands of the Kelly Gold and Silver Mines, Inc., but reverted to Gibson and Main in mid-1936. In April 1944 the mine was purchased by Frank Royer, the present owner. Since 1931 the mine has been worked intermittently by lessees. According to Tucker and Sampson,[132] from August 1933 to May 1937 the output was valued at $723,443.

Deposits in Other Areas

Akron-Silver Reef Deposit. Location: secs. 3 and 4, T. 3 N., R. 2 E., and secs. 33 and 34, T. 4 N., R. 2 E., 12 airline miles southeast of Lucerne Valley. Ownership: J. J. McLaughlin, 135 South Commonwealth, Los Angeles, California, owns 27 claims.

The Akron-Silver Reef deposit consists of silver bromide and silver chloride minerals and subordinate gold sparsely disseminated in a pebble-to-boulder limestone breccia. Mining activity has been limited to open-cut development of the deposit, and to an experimental operation of a cyanide plant on the property. By early 1952 no shipments had been made. The owner reports that the property was worked for high-grade silver ore prior to 1900.

The deposit is exposed on one of numerous, low, northeast-trending ridges of limestone breccia projecting above the Quaternary alluvium that flanks the northern slope of the San Bernardino Range. The breccia, probably also Quaternary in age, appears to consist of fragments of the Furnace formation and to be of sedimentary origin. It consists mostly of fragments 3 to 5 inches in diameter in fine-grained matrix. The operators state that the ore minerals are confined to the matrix, and that the average value of the material sampled to date is between $3 and $3.25 per ton.

[132] Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, p. 483, 1943.

Annex (Silver Hills) Mine.[133] Location: sec. 26, T. 17 N., R. 8 E., S.B.M., on the west slope of the Silurian Hills, and 18 airline miles north of Baker. Ownership: George Peterson and Albert E. Barton own 4 claims.

Since the Annex mine was first seriously worked in 1947 it has yielded a modest tonnage of high-grade silver ore. This was mined by lessees. In mid-1952 the mine was idle.

The silver minerals occur as veinlets in a series of dolomite and quartzite beds, part of the Crystal Spring (Algonkian) formation. The beds strike N. 65° W., and dip 60° to 70° S., and, to the southwest, are in fault contact with a complex of quartzite and granitic rock.

Silver minerals have been noted along the length of two claims. The principal zone of veinlets, the ''Memorial Day vein,'' is several hundred feet long. It strikes N. 36° W., dips 50° S., and consists of a zone of gouge and dolomite breccia. It ranges from a few inches to as much as 10 feet in exposed width. It has been mined by means of an irregular open cut about 35 feet long, joined to several short adits.

An outcrop to the east of the Memorial Day workings has been designated the ''Easter Day vein'' and a mineralized zone 40 to 50 feet south of the Memorial Day vein is called the ''Mother Lode vein.''

By mid-1952 development work consisted of the workings noted above together with numerous prospect holes and shallow cuts. Early in 1948 eighty-one tons of high-grade ore had been shipped from the open cut. The ore was hand sorted, sacked and hauled by means of a light aerial tram a distance of 1400 feet, where it was loaded into trucks and hauled to Dunn, a shipping point on the Union Pacific Railroad. A road half a mile long has since been constructed to a loading bin on the property.

Waterman Mine. Location: sec. 13, T. 10 N., R. 2 W., and sec. 18, T. 10 N., R. 1 W., in the old Grapevine district about 4 airline miles north of Barstow, and about 10 airline miles west of the Calico district. Ownership: Robert W. Waterman, Box 15, Daggett, California, owns 2 patented and 2 unpatented claims.

The Waterman mine, most actively worked during the bonanza period of the nearby Calico district, yielded $1,700,000 in silver from 1882 to 1887.[134] In the period 1887 to 1909 the mine was worked by lessees and on a smaller scale. Except for a small operation which in 1931 recovered barite from mill tailings, the mine has been idle since 1887.

In most respects the Waterman deposit resembles those of the Calico district. The veins occur in a series of interbedded rhyolite, rhyolite tuffs, lake sediments, and fanglomerates. The series strikes north to northwest and dips steeply westward.

The mine workings have followed a mineralized zone vein one to 8 feet wide and 1200 or more feet long. It lies at a contact between rhyolite on the footwall and rhyolite tuff on the hanging wall. It strikes due north in its southerly exposures then curves northwestward. The vein dips steeply west at the surface, but dips irregularly at lower levels and is trough-shaped near the 200-foot level. It consists of a barite-jasper gangue containing native silver and silver sulfides. Silver chlorides exist near the surface. The ore averaged about 41½ ounces of silver per ton, according to the owner.

[133] Much of the data in this description was obtained in personal communication with Dion L. Gardner and L. A. Norman, Jr.
[134] Waterman, R. W., personal communication, 1951.

Underground workings include two shafts 400 and 300 feet deep, and about 600 feet apart. Drifts have been driven on the 100-, 200-, 300-, 400-, and 500-foot levels. The 500-level is reached by a winze driven from the 400-foot level. The main vein has been stoped from the 300-foot level to the surface for about 1000 feet along the strike. On the 200-, 300-, and 400-foot levels crosscuts have been driven west to 2 parallel veins and exploratory drifts from 100 to 200 feet long have been driven.

From 1882 to 1887 a 10-stamp mill operated at Barstow, then known as Waterman. During its operation 40,000 tons of ore were treated. In 1931 a flotation plant of 100-ton capacity was in operation to recover barite from the old tailings. Twenty tons of barite of specific gravity 4.3 carrying 3 ounces of silver per ton were recovered daily for use in drilling mud. The property has been idle since then.

Tin

Tin minerals are known to exist in San Bernardino County only in the southwestern foothills of the Ivanpah Mountains at a locality about half way between Cima and Mountain Pass. Here cassiterite ore has been removed from the Evening Star mine described in the following section on tungsten. Cassiterite has also been noted at several nearby properties, but not in proved commercial concentrations.

Tungsten

The total value of tungsten ore produced in San Bernardino County has not been recorded separately, but probably exceeds that of any other metal, with the possible exception of silver. For the years 1915-18, when tungsten production figures were published, the total value exceeded $9,000,000. It is estimated that by 1952, production from the mines in the Atolia district, which is by far the most important tungsten-producing area in the county, had exceeded 1,000,000 units of WO_3. The second highest production has come from the Starbright mine, 21 miles north of Barstow, which by mid-1951 had yielded 10,000 tons of ore averaging from $1\frac{1}{2}$ to 2 percent WO_3. Tungsten-producing areas of lesser importance include the Shadow Mountains area north of Adelanto and the Old Woman Mountains south of Essex. Late in 1951 a deposit was briefly worked in the Clipper Mountains, an area not previously known to contain tungsten.

Tungsten deposits in San Bernardino County have four principal modes of occurrence: (1) scheelite in quartz-carbonate veins as in the Atolia district; (2) scheelite in contact-metamorphic deposits as at the Starbright mine, Shadow Mountains and Old Woman Mountains areas; (3) scheelite associated with wolframite in quartz veins as in the Clark Mountain area; and (4) wolframite and hubnerite in quartz veins and pegmatite dikes as in the Camp Signal area north of Goffs and the New York Mountains.

Atolia District [135]

The Atolia district, where the largest bodies of high-grade scheelite in the United States, if not in the world, have been mined, by 1952 had yielded more than 1,000,000 units of WO_3. The district remains one of the

[135] Much of the data in this section has been obtained from the following references:
Hulin, C. D., Geology and ore deposits of the Randsburg quadrangle, California: California Min. Bur. Bull. 95, 152 pp., 1925.
Lemmon, D. M., and Door, J. V. N., 2nd, Tungsten deposits of the Atolia district, San Bernardino and Kern Counties, California: U. S. Geol. Survey Bull. 922-H, pp. 205-245, 1940.

nation's principal tungsten sources. The known deposits, both lode and placer, occur in a belt about 2 miles long and half a mile wide, lying partly in Kern County, mostly in San Bernardino County. The district is about 4 miles south of Johannesburg and Randsburg and is joined to them by U. S. Highway 395.

Since its discovery in 1904, the district has been in nearly continuous operation. Its only inactive period, in 1920 and 1921, was caused by a collapse in tungsten prices following World War I. In 1917, the most productive year, an output of 116,307 units was recorded. Mainly because of low prices, the annual production rate during the depression years 1929 to 1933 dropped to about 5,300 units. Since 1933, stimulated by the price increases, the yearly average has been about 15,000 units.

The richest of the known placer deposits, commonly called the "Spud Patch," are confined to an area of about one-fourth of a square mile in the southeastern corner of the district. These have contributed between 5 and 10 percent of the total production. The remainder has been obtained from veins distributed throughout the rest of the belt. The veins have been developed by about 35 individual mines.

For a period of 38 years beginning in 1905, most of the productive part of the Atolia district was under the control of the Atolia Mining Company. In 1943 the company's operations were taken over by Hoefling Brothers, later known as the Surcease Mining Company. The property involved is covered by 55 patented lode claims forming an east-trending block in the central part of the district, and by placer holdings which include virtually all of the Spud Patch. At the western end of the property is the Union mine, by far the district's largest in both extent and output. Nearby are the Star, Amity, and Attila workings. In the central part, west of U. S. Highway 395, the Goldstone, Rainstorm, Viewpoint, Acaley, Neglected Fraction, and Moonstone workings form a group with an insignificant production. East of the highway are the Piute, Papoose, Little Papoose, Mahood, Flatiron, Par and Spanish, and Paradox workings.

Around the periphery of the Surcease holdings are numerous claims held by other companies and individuals. These contain workings that have been active for relatively short periods and whose output has been but a small fraction of the total for the district. The most productive of these operations have been those on the lode and placer deposits of the Osdick claims in the northeast corner of the district. These were most actively worked during World War I. Other nearby workings include the Federal mine, the Redondo Pete shaft, and the Long's Folly shafts.

The Spud Patch has been penetrated by an estimated 300 to 400 shafts, ranging from a few feet to about 60 feet in depth, from which drifts have followed productive buried channels. When operated by the Surcease Mining Company, from December 1942 to June 1949, scheelite-bearing channels were uncovered in large open cuts.

When controlled by the Atolia Mining Company, both the vein and placer deposits were worked almost wholly by lessees. The company operated a mill and, from time to time, engaged in limited mining operations. The Surcease Mining Company continues to provide underground lode leases and to purchase and mill the ore, but undertook, on its own, the large-scale operation of the Spud Patch. In 1943 this company also independently began to recover ore of low average grade from a series of open cuts along several of the principal veins and vein systems; these operations were continuing in mid-1952.

FIGURE 20. Open-pit operations of Surcease Mining Company on tungsten lode deposits, Atolia. Pit lies immediately east of Union shaft. Scheelite-bearing quartz-carbonate veins cut quartz monzonite exposed on quarry face. Observer faces east.

The Atolia district, an area of low relief, is underlain principally by granitic rock, known as the Atolia quartz monzonite and probably of late Jurassic age. This rock is cut by diorite, aplite, and granite dikes, probably pre-Tertiary in age, and by two diabase dikes. To the east, non-marine Tertiary sediments overlie the quartz monzonite. Most of the bedrock surface is covered with Quaternary alluvium, ordinarily only a few feet thick, but exceeding 100 feet in thickness in the western and southeastern parts of the district.

The Atolia scheelite-bearing veins occupy a series of faults which, in general, trend east-northeast and dip moderately to steeply northward. The ore bodies, which exist as shoots in the veins, probably do not average more than 100 feet in maximum dimension. The minable bodies have ranged in thickness from about one inch to as much as 17 feet. The largest known body, encountered in the South vein of the Union mine, is more than 1,200 feet in exposed length and as much as 17 feet wide.

The ore bodies are composed of scheelite, the only ore mineral, in a gangue of quartz and carbonates (calcite, ankerite, dolomite, and siderite). Pyrite, stibnite, and cinnabar are locally present in subordinate proportions. The scheelite occurs in veinlets and in individual masses from a fraction of an inch to several feet in diameter. All of the veins are bordered by alteration zones from a few inches to several feet thick. In these zones the quartz monzonite contains abundant sericite, pyrite, and kaolin (?) and some chlorite.

Previous to the initiation of the large-scale, open-cut mining methods in 1943, the ore mined and milled by the Atolia Mining Company since 1909 probably averaged slightly more than 4 percent WO_3. Yearly averages ran as low as one percent and as high as 15 percent. The over-all average has been lowered in recent years by the removal of large tonnages of rock averaging a small fraction of one percent. The richest ore shoots have been found in the western and eastern parts of the district. The western mines (Union and Amity) have been about three times as productive as the eastern mines (Papoose, Flatiron, Par, and Paradox).

Placer scheelite is widely, but unevenly, distributed in the alluvium that covers and flanks the Atolia district. The placer deposits of greatest commercial interest are in the relatively thick, stratified deposits in the district's most westerly and southeasterly parts. The western deposits have been worked primarily for gold, but have yielded byproduct scheelite. The southeastern deposits, which comprise the Spud Patch, have been worked mainly for scheelite.

In the Spud Patch the richest placers lie in old stream channels incised upon a buried surface underlain partly by quartz monzonite, partly by non-marine Tertiary sandstone. The channels trend eastward and have been worked laterally for distances of 3000 to 4000 feet. The scheelite concentrations lie at several levels; the deepest worked to date are about 90 feet beneath the surface. Much of the material recovered from the Spud Patch has been quite coarse, the area having derived its name from an abundance of potatolike pieces of scheelite.

Atolia Mines (Mines Now Operated by Surcease Mining Company, Formerly Operated by Atolia Mining Company; Includes the Acaley, Amity, Attila, Flatiron, Goldstone, Mahood, Par and Spanish, Papoose, Paradox 1 and 3, Rainstorm, Spud Patch, Star 1, and Union Mines.) Location: principally secs. 19 and 20, T. 30 S., R. 41 E., M.D.M., about

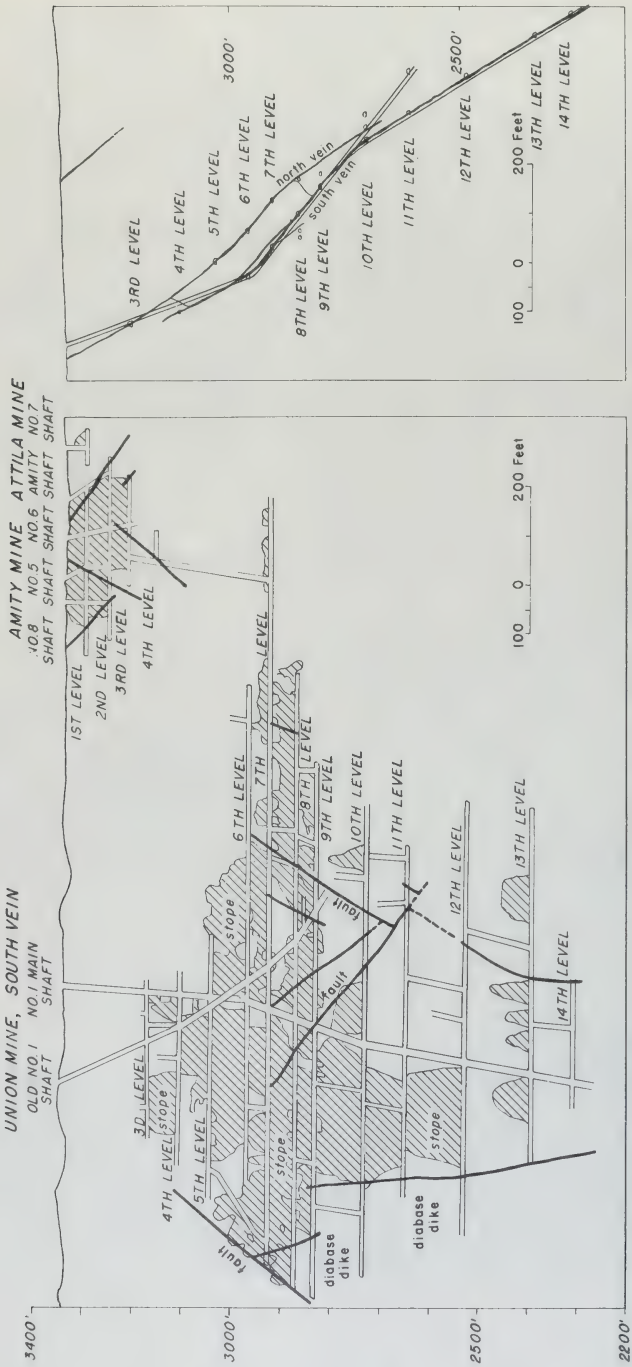

FIGURE 21. Sections through the Union and Amity mines, Atolia district, after Dwight M. Lemmon and John V. N. Dorr, 2d. U. S. Geological Survey Bulletin 922-H.

4 miles south of Randsburg and Johannesburg; traversed by U. S. Highway 395. Ownership: The Atolia Mining Company, 1022 Crocker Building, San Francisco, California, owns 55 patented lode claims; all are leased to the Surcease Mining Company (formerly Hoefling Brothers), Box 786, Sacramento, California. The Surcease Mining Company owns 12 placer claims.

Although the Atolia mines continue to be active, there has been no major underground development since the district was described by Lemmon and Dorr in 1940.[136] Lessees have recovered ore mainly in the zones of proved mineralization, and have worked principally through shafts sunk many years ago. Of most interest in recent years have been the Spud Patch excavations, active during the period 1943-50, and the large-scale open pit mining which is continuing.

As noted above, the workings and the deposits at the Union mine are by far the most extensive in the district. The workings extend to a maximum vertical depth of 1,021 feet, and lie mostly along two veins, known as the North vein and the South vein. In general, these strike westward, dip about 60° N., and converge downward. A maximum horizontal separation of 180 feet was observed in the western part of the mine; the veins intersect in the eastern part.

The ore has ranged in width from one inch to as much as 17 feet, and in some places on the south vein was mined as lenses of nearly pure scheelite 5 to 10 feet thick. Most of the ore has been mined from two shoots, each V-shaped downward, and was richest where the veins flattened to about 40°.

The Union workings contain 14 levels; the upper eight average about 1300 feet long; the 14th level is about 250 feet long. Of the six shafts on the property, only two, the No. 1 shaft (now in use) and the Old No. 1 shaft (abandoned) extend below the 4th level. Since prior to 1940 the mine has been water-filled beneath the 11th level.

Of the other Atolia mines, all but the Amity, Flatiron, Papoose, and Par and Spanish are less than 200 feet in maximum depth. These four, as shown by Lemmon and Dorr,[137] are 410, 262, 361, and 210 feet deep, respectively. Moreover, these four, together with the Paradox No. 3, were the only workings which in 1940 exceeded 1000 feet in total length.

In the recent open cut operations at the Spud Patch, as much as 90 feet of overburden was removed to reach channels of scheelite-bearing gravel 8 to 9 feet thick. Boom drag lines were employed. The material was hauled to stock piles, thence bulldozed to the plant.

The surface operations in the areas of the vein deposits have been confined mainly to four large cuts, one each above the Union, Amity, and Papoose workings, and a fourth (the Churchill) between the Union and Amity. These are elongate cuts, ordinarily 100 to 200 feet wide and 30 to 60 feet deep. The quartz monzonite has weathered to depths of 50 to 100 feet, and is quite easily broken. The broken rock is removed selectively by drag lines; the material richest in scheelite is trucked to a nearby mill.

Two mills are currently in use. Ore mined by lessees is treated in the old Barker Mill west of U. S. Highway 395, and about one mile south

136 Lemmon, D. M., and Dorr, J. V. N., 2d, Tungsten deposits of the Atolia district, San Bernardino and Kern Counties, California: U. S. Geol. Survey Bull. 922-H, pp. 205-245, 1940.

137 Lemmon, D. M., Dorr, J. V. N., 2nd, op. cit.

of Red Mountain. Ore obtained in company operations is concentrated in a semi-portable placer mill in the Spud Patch.

At the Barker mill the ore is run through a jaw crusher and ground to minus 10 mesh in a ball mill. It is then passed over three concentrating tables arranged in parallel. Middlings are carried to another table whose middlings are in turn returned to the ball mill.

At the other mill, ore is discharged onto a trommel and split into three sizes. The ore of the two larger sizes is carried by belt through dark rooms, where it is hand sorted with the aid of ultra violet lamps. The fines are passed through jigs.

Deposits in Other Areas

Celestial Deposit. Location: secs. 4, T. 12 N., R. 2 E., S.B.M. (projected), about 27 miles northeast of Barstow, and only a few hundred feet south of the Camp Irwin boundary. Ownership: Walter F. and Violet Mercier, Harvey F. and Fred H. Vice, Reseda, California, own one placer and one lode claim.

The Celestial is a little-developed prospect which contains scheelite sparsely scattered through crystalline limestone and in small tactite bodies in the limestone. The limestone body is exposed on a sharp, northwest-trending ridge, and is bordered by granitic rock and alluvial cover. The limestone exposures are approximately 600 feet long and 200 feet wide. A thin zone of tactite, as much as two feet thick, is exposed along a contact with the granitic rock on the northeast side of the hill. Most of the limestone is apparently barren of scheelite. The deposit has been explored by a 35-foot shaft sunk on an inclination of 60° northeast in the limestone. The walls and bottom of the shaft show no scheelite. The dump above the shaft, however, contains fragments of garnet-epidote tactite and quartz carrying scheelite which apparently came from a small, irregularly shaped stope near the top of the shaft.

Clipper Mountains Mine. Location: secs. 14 and 23, T. 8 N., R. 15 E., S.B.M., on the northeast slope of the Clipper Mountains about 10 airline miles north of Danby. Ownership: Oscar L. Hoerner and associates, Newberry, California, and Ralph W. Ross, 710½ Park Avenue, South Pasadena, California, own 11 claims.

The Clipper Mountain tungsten deposit, located in August 1951, was first worked from November 1951 to late February 1952 by the Pinnacle Tungsten Company, controlled by O. R. Heidrich, Daniel V. O'Flaherty, and John Fleming, 5658 Wilshire Boulevard, Los Angeles, California. This operation resulted in the production of a little less than 150 tons of tungsten ore, from which about 96 units of WO_3 were recovered.

The property is in an area not previously known to contain tungsten minerals. Most of the mine area is underlain by Archean gneiss and biotite schist, capped by Pleistocene tuff and basalt. Small, thin lenses of limestone are enclosed by the schist. The Archean rocks contain irregular intrusive bodies of quartz diorite. The limestone near the quartz diorite contains small, discontinuous bodies of friable, garnet-rich tactite. Scheelite is disseminated unevenly in these tactite bodies.

Two tactite zones have been explored by inextensive workings from which a small quantity of ore was extracted. A steeply dipping zone, trending northeastward, has been developed by a cut 25 feet long and 6 to 8 feet wide, driven southwestward into the slope. About 20 feet higher and to the south a 15-foot, nearly vertical shaft has been sunk

on the same zone. Another tactite body west of these workings strikes N. 50° W., dips 60° SW. and has been explored by 60 feet of trench and a shallow underhand stope, 15 feet in maximum depth. Other workings consist of small stripped areas and shallow cuts.

Exploration was continued by the owners after the withdrawal of the Pinnacle Tungsten Company, but no further production had been made by mid-1952.

Evening Star (Bernice, Rex) Mine. Location: secs. 24 and 25 (?), T. 15 N., R. 13 E., S.B.M., about $7\frac{1}{2}$ airline miles south of Mountain Pass and about 31 airline miles east of Baker in the western foothills of the Ivanpah Mountains. Ownership: C. F. Wendrick Jr., Steel Service and Sales Company, 53 West Jackson Boulevard, Chicago, Illinois, owns 10 claims.

The Evening Star mine on the Bernice claims, though yielding tungsten ore in 1939-40 and tin ore in 1942-44, has a small total output. Since 1944 the mine has been unproductive, but the area has been intermittently explored for tungsten and copper. A shaft, reported [138] to be 740 feet deep, was sunk in search of copper on the Rex claim in the period 1900-10, but no level workings were driven and no production resulted. The mineralized zone is at or near a contact between a quartz monzonite body underlying the central part of the Ivanpah Mountains and the dolomitic limestones exposed on the west flank of the range. Bedding in the limestone strikes northeastward and dips 35°-50° westerly.

Cassiterite, in varying but generally low proportions, is disseminated throughout the contact zone. The tin production noted above, however, was obtained mostly from concentrations in an irregular, cylindrical body of tremolite-bearing calcite in the limestone. The body is a pipe-like mass, about 10 feet in maximum diameter, and lies at the intersection of two veins raking from 20° to 35° westward and plunging 70°. The cassiterite is most abundant along fractures at the margin of the body, where it is associated with hematite and magnetite. Other minerals present include wollastonite, pyrite, chalcopyrite, and traces of scheelite.

The cassiterite was mined mostly through a shaft (No. 1) inclined 80° westward for 35 feet, then 45° for 70 feet. Ore also was obtained from a vertical, 100-foot shaft (No. 2) about 100 feet to the west and from surface cuts. One shipment of ore, averaging about 6 percent tin, was shipped to Texas City, Texas, but more than 400 tons of the ore was milled at the company's mill at Windmill Station, 10 miles north of the mine. Several tons of concentrates were sold to the government stockpile at Jean, Nevada. In 1944 long hole (50 foot) drilling from the bottom of the vertical shaft failed to encounter ore.

In 1949, another vertical shaft, 400 feet west of the No. 2 shaft, was sunk 67 feet on a copper-bearing siliceous vein. Nearly 50 tons was stockpiled but not shipped. Minerals in the rock include pyrite, chalcopyrite, and carbonates of copper.

The area of principal tungsten mineralization is in tactite bodies along a sinuous granite-limestone contact exposed on a small hill a quarter of a mile southeast of the tin workings. Various workings, including several shallow shafts and many surface cuts, expose the tactite zone

[138] Bembry, J. Riley, personal communication, 1952.
Tucker, W. B., and Sampson, R. J., op. cit., 1943.
Haythorne, C. L., personal communication, 1952.

over an area of several acres. In 1939-40 the western part of this area was leased to W. W. Hartman of Los Angeles, who shipped about 1,000 tons of tungsten ore to the mill at the Valley View gold mine.

Exploration in the tungsten area, resumed in June 1951, consists of the extension of an old adit southeastward through nearly barren limestone toward the granite contact. The adit was 340 feet long by February 1952, but the contact had not been reached.

Hidden Value (Hidden Value and Victory) Mine. Location: secs. 6 and 8, T. 5 N., R. 17 E., S.B.M., in the north end of the Old Woman Mountains. Ownership: L. T. Rouchleau, 2700 Budlong Avenue, Los Angeles, California, and Mrs. M. M. Richardson, Los Angeles, California, own two groups of claims, the Hidden Value group of 13 claims and the Victory group of 8 claims, plus a millsite at Danby.

The Hidden Value mine has been operated intermittently since 1943 and has yielded a little over 500 units of WO_3. More than two-thirds of this was mined during World War II. From early 1943 through 1945 a total of 333 units of WO_3 was produced from ore which, according to the owner, averaged 2.75 percent WO_3. During this period a loan from the Reconstruction Finance Corporation was used to aid in building roads and developing the mine.

The scheelite on the Victory group is reported by Tucker and Sampson[139] to occur in veins in granite. On the Hidden Value group where most of the mining has been, scheelite occurs in tactite developed in Archean metamorphic rocks, consisting of limestone and schist, near a Jurassic granitic body. The tactite belt strikes N. 40° E., dips 30° to 40° NW., and ranges in width from 250 to 300 feet. There are several scheelite-rich lenses 10 to 36 feet wide and 70 to 250 feet long within the tactite zone. The grade of the ore in these lenses ranges from 0.5 to 3 percent WO_3.

Ore has been mined from adits and transported down a 2500-foot aerial tram to a storage bin. It is hauled by truck 16.5 miles to a 10-ton mill at Danby, where it is crushed, ground to 16-mesh in a 4-foot ball mill and concentrated on a 5- by 14-foot table. A 65 percent WO_3 concentrate can be made, but the tailings assay from 1 to 1.5 percent WO_3; these are being saved for future treatment.

Howe Tungsten (Section 9) Mine. Location: sec. 9, T. 5 N., R. 17 E., S.B.M., in the north end of the Old Woman Mountains, 11 airline miles southeast of Danby. Ownership: Walter Zindell, Essex, California owns a patented section plus a millsite at Danby.

This property was first mined during 1944 when, according to the owner, it yielded 218 tons of ore averaging 4.35 percent WO_3. A much smaller tonnage has been mined since.

A tactite zone is developed in Archean metamorphic rocks, principally crystalline limestone and mica schist, and is parallel to and possibly an extension of the mineralized zone on the Hidden Value mine to the southwest. The zone strikes N. 40° E., and dips 30° NW. Scheelite is disseminated in the tactite.

Ore has been mined from a lens, 6 to 10 feet wide and about 150 feet long, by means of an open cut 100 feet long and 24 feet in maximum depth. Ore was transported over an 1800-foot aerial tram to a bin on the road just north of the ore bin of the Hidden Value mine.

[139] Tucker, W. B., and Sampson, R. J., op. cit., p. 503, 1943.

Early in 1952 the owner had completed a small concentrating plant in which the ore was to be crushed to 6-mesh and concentrated by means of a jig.

Just Tungsten Quarries (Just Associates, Princess Pat, Shadow Mountains Mines). Location: secs. 30 and 31, T. 8 N., R. 6 W., S.B.M., on the northwest flank of Silver Peak, Shadow Mountains, about 13 airline miles west of Helendale and 14 airline miles northwest of Adelanto. Ownership: Just Associates, E. Richard Just and Oliver P. Adams, 726 Story Building, Los Angeles, California, own unpatented claims totaling 440 acres. The property is leased to Just Tungsten Quarries, E. Richard Just and associates, 726 Story Building, Los Angeles, California.

The deposit, now known as the Just Tungsten Quarries, was discovered in 1937. Operations from late 1937 to early 1938 by the Shadow Mountains Tungsten Mines and W. A. Trout and C. A. Rasmussen resulted in the recovery of about 750 units of WO_3 from nearly 3000 tons of selected ore treated in a 40-ton mill on the property. The operation was not successful and the mill was dismantled. During the mid-1940's lessees mined about 400 tons of ore, and during the late 1940's the Princess Pat Mining Company leased the property but apparently produced no ore. Operations from April 1952 to mid-1952 have yielded a few hundred tons of ore of undisclosed grade.

The scheelite occurs in quartz veins cutting garnet-epidote-quartz tactite bodies which exist at the contact between a Mesozoic granitic rock and Paleozoic (?) metamorphic rocks, mostly impure limestone and schist. The foliated rocks strike slightly north of east and dip gently south. Scheelite-bearing tactite also has been developed, away from the contact, along beds in the limestone, to form thin bodies of ore separated by barren limestone beds.

The deposit was explored during 1937-38 by 1800 feet of zig-zag trenches, 10 feet wide and 6 to 10 feet deep, excavated by a power shovel up a moderate slope in a southwesterly direction. A 65-foot vertical shaft was sunk near the lower end of this trench system, but no mining was done underground.

Employed in the early prospecting was a large field-type lamp requiring a 110-volt current, and a portable gasoline-powered motor generator set. This may have been the first practical application of a lamp of this type.

Ore is being mined from a bench cutting into a trenched area about 50 feet north of the shaft. Mining operations are carried on at night, and the ore is sorted with the aid of ultra-violet light. Shipments have been made to both the Jaylite and Parker custom mills in Barstow.

Lucky Lode (Silver Star) Deposits. Location: sec. 7 (?), T. 15 N., R. 14 E., S.B.M., in the western foothills of the Ivanpah Mountains, about 5 airline miles southeast of Mountain Pass and about 32 airline miles east of Baker. Owners: Jay Ricketts, Tustin, California, T. L. Button, Cima, California, and Elmer Schneider, Santa Ana, California.

The Lucky Lode is a little-explored tungsten prospect. Two pits, each less than 10 feet deep and about one-half mile apart, expose granitic rock with inextensive zones that contain quartz veins, garnet and epidote. This mineralized zone is several hundred feet east of a quartz monzonite-limestone contact.

Mary Ann Mine. Location: sec. 31, T. 8 N., R. 6 W., S.B.M., on the northwest flank of Silver Peak, Shadow Mountains, about 13 airline miles due west of Helendale and 14 airline miles northwest of Adelanto. Ownership: Adelanto Mining Company, Nicholas Baxter, president, Adelanto, California, is leasing 180 acres to George Kablitz, See Drive at Hadley, Whittier, California. Mining is contracted to Barry J. Spender, 14854 Tamarix Drive, Puente, California.

The Mary Ann mine is a recently-opened prospect from which a small tonnage of tungsten ore had been shipped to the Midwest Milling Company, Los Nietos, in early 1952. Scheelite occurs in a garnet-quartz tactite zone of varying width along a shattered granite-limestone and schist contact. Ore of highest value is found on the granite side of the zone. Two men were working in the spring of 1952, to develop the property.

Moonlight and Tungsten King Deposits. Location: sec. 32, T. 31 S., R. 47 E., M.D.M., and sec. 4, T. 32 S., R. 47 E., M.D.M., in the low hills east of Superior Dry Lake, southwest of Goldstone, and approximately 25 miles northeast of Barstow. Ownership: Ray Jones and Frank Jones, Barstow, California, own nine claims.

The Moonlight and Tungsten King are undeveloped tungsten prospects explored (in 1952) by only a few shallow pits and trenches.

The deposits consist of several scheelite-bearing quartz veins in a dark gray granitic rock (probably Mesozoic diorite or quartz diorite) which is the principal rock underlying the prospect area and the surrounding hills. The veins strike northeast and dip moderately northwestward. The largest vein, with a width of as much as 3 feet and an average width of several inches, is discontinuously exposed but can be traced for more than 1000 feet on the surface. The other veins are thinner and less than 100 feet in exposed length.

The scheelite in the quartz is generally fine-grained and thinly disseminated, but it occurs locally in high-grade clusters as much as 5 inches in diameter. The operators report that scheelite also occurs in the granitic rock adjacent to the veins.

Pure Quill Deposit. Location: sec. 4, T. 6 N., R. 1 E., S.B.M., near Salvation Well on the south slope of the Ord Mountains and about 18 miles north of Lucerne. Ownership: G. D. Hedrick, Hesperia, and Leonard Shoush, San Gabriel, own two claims.

The Pure Quill tungsten prospect was discovered in January 1951 by the present owners. For a period of several months in 1951 and 1952, the property was leased to Allen Kisock and Company, 70 Pine Street, New York, New York, by whom most of the development was done.

The deposit consists of scheelite discontinuously disseminated in an amphibolite layer within a crystalline rock complex of probable pre-Cambrian age.[140] The complex, chiefly quartzite, mica schist, and foliated granitic rocks, is cut by acidic and basic dikes. The amphibolite layer, composed essentially of dark green amphibole with subordinate plagioclase is from 5 to 20 feet wide, and can be traced laterally for at least 1000 feet. Locally it contains irregular quartz masses with which scheelite is associated. Scheelite occurs within the quartz and within amphi-

[140] Gardner, D. L., Geology of the Newberry and Ord Mountains: California Div. Mines Rept. 36, pp. 262-263, pl. II, 1940.

bolite near quartz contacts. The amphibolite layer and planar structures of the other units of the complex strike northwest, and dip steeply southwest.

The property was first explored by several small cuts. Later a tunnel was driven southwestward 200 feet, encountering the tungsten-bearing zone at 170 feet. The zone was followed by drifts 138 feet northwest and 87 feet southeast. In mid-1952 the property was idle.

Riley (Standard No. 1, Excelsior) Mine. Location: secs. 18, 19, T. 15 N., R. 14 E., S.B.M., about 6 airline miles southeast of Mountain Pass and 32 airline miles east of Baker, in the western foothills of the Ivanpah Mountains. Ownership: J. Riley Bembry, Cima, California, owns 3 claims.

Prior to 1902 the Riley mine, then known as the Excelsior copper mine, yielded a significant tonnage of copper ore.[141] Operations from 1902 to 1908, when it was known as the Standard No. 1 mine, obtained copper-gold-silver ore valued at about $75,000. After long idleness, in 1940-41 the property was leased by W. W. Hartman of Los Angeles, who mined a small tonnage of tungsten ore. In 1951 tungsten explorations by another lessee, the California Tungsten Corporation, were unsuccessful.

The deposits lie at or near a contact between limestone and the quartz monzonite that underlies much of the Ivanpah Mountains. The copper mineralization is localized along a vertical, northwest-trending fault in the limestone and about 150 feet west of the quartz monzonite contact. Coatings and thin layers of malachite, azurite, and chrysocolla follow fractures and bedding planes in the limestone. Scheelite is irregularly distributed in discontinuous tactite bodies near the fault and along the limestone-quartz monzonite contact.

Prior to 1908, all mining was done underground through a vertical shaft following the contact zone and reported to be several hundred feet deep with extensive lateral workings.

Recent development work consists of a series of open cuts, trenches, and relatively shallow shafts and adits along the fault zone in the limestone-tactite. The workings follow irregular shoots rather than a single vein, and expose the mineralized zone discontinuously for about a quarter of a mile along its strike and across a width of as much as 100 feet.

Shooting Star Mine (United Tungsten Copper Mines). Location: secs. 28 and 29, T. 2 N., R. 3 E., S.B.M., near Rattlesnake Canyon in the eastern San Bernardino Mountains about 7 airline miles southeast of Baldwin Lake and 17 airline miles northwest of Yucca Valley. Ownership: John S. Burbridge, 11458 Albert Street, North Hollywood, California, owns 5 lode and one placer claims, all under lease to Shooting Star Tungsten Company, J. A. Vandegrift, agent.

The Shooting Star mine is a small tungsten mine which, under the name of United Tungsten Copper Mines, produced an undetermined but small tonnage of reportedly marginal ore in 1916-1918. After many years idleness the property was relocated as the Shooting Star mine in 1949 and the present lease was taken in mid-1951. The first shipment of 100 tons of ore was made in May 1952, to the Jaylite mill in Barstow.

[141] Bembry, J. Riley, personal communication.

The country rock in the mine area consists of granitic intrusive rock containing masses of dolomitic limestone. The Shooting Star orebody lies at a limestone-granite contact, where scheelite is developed with garnet, quartz, and epidote. The mineralized zone strikes northeast, dips moderately northwestward, and is not over 8 feet wide as exposed. Level workings total about 1000 feet, including an irregular main adit driven southwestward for about 300 feet. The zone is also exposed in surface trenches along several hundred feet of its length. Ore bodies have been mined from overhand stopes.

Silverado-Tungstite Claims. Location: sec. 18, T. 15 N., R. 14 E., S.B.M., about 6 airline miles southeast of Mountain Pass and 32 airline miles east of Baker, in the western foothills of the Ivanpah Mountains. Ownership: J. Riley Bembry, Cima, California, owns four unpatented claims.

A small tonnage of silver ore was shipped from the Silverado claim prior to 1900.[142] Otherwise the claims are undeveloped. Some of the Tungstite group were located as recently as 1951. The claims cover a north-trending contact between dolomite and dark granitic rock. Along the contact lies a zone of tactite as much as 50 feet wide. The dolomite strikes northward and dips moderately westward. The contact is sheared and heavily stained with limonite. Concentrations of iron minerals and silica occur in the limestone.

The zone is explored and exposed for about 300 yards by 8 pits and shafts ranging in depth from 30 to 50 feet. Tactite is best developed in the Tungstite claims at the north end of the group and has been exposed by trenching over an area about 100 by 500 feet. Small amounts of scheelite are unevenly and sparsely distributed in the tactite.

Starbright Tungsten Mine. Location: sec. 19, T. 12 N., R. 1 E., S.B.M., 21 miles north of Barstow on Bicycle Lake road, and 5 miles west of the road and 3 miles northeast of Lane Mountain. Ownership: A. C. Lambert, Barstow, California and Clair Dunton, Mineral Materials Company, 1145 Westminster Avenue, Alhambra, California, own 9 claims, all leased to the Mineral Materials Company.

The discovery of the Starbright deposit in 1950 was the most significant tungsten development in California in recent years. By mid-1951 the mine had yielded over 10,000 tons of ore averaging 1½ to 2 percent WO_3, the largest output of any San Bernardino County tungsten mine outside of the Atolia district. The mine was still active in mid-1952.

The Lane Mountain region is underlain by a complex of plutonic igneous rocks ranging from quartz diorite to gabbro in composition. Within the complex are masses of metamorphosed sediments believed to be Paleozoic in age. One of the smaller of these masses contains the Starbright deposit.

The deposit is a tactite body, irregularly ovoid in outcrop pattern and trending nearly east-west. In plan it is about 100 feet long and 40 to 50 feet wide. It dips to the south at about 45 degrees, the footwall less steeply than the hanging wall. The tactite, composed mostly of garnet,

[142] Bembry, J. Riley, personal communication.

is intimately crushed. Scheelite, the tungsten-bearing mineral, is disseminated through the tactite.

For more than a year the deposit was worked by open pit methods to a depth where the southerly dip of the oreshoot made such methods impractical. Diamond drilling located an extension of the orebody which was reached by an 80-foot shaft inclined 25° south. An easterly drift on the 80-foot level was 30 feet long in May 1952.

Most of the ore was shipped to the El Diablo mill at Bishop. Ore recently obtained from the underground operations has been treated at the Jaylite mill at Barstow.

White Dollar Mine. Location: secs. 7, 8, T. 7 N., R. 2 E., S.B.M., in the Ord Mountains about 11 airline miles southward from Daggett. Ownership: J. Ralph McInerny, Route 1, Box 314 A, San Bernardino, California owns 3 claims, one of which is leased to Frank R. Parker, Parker Mining and Milling Company, Box 202, Barstow, California, and subleased to John Polson and Wallace Salsbury, Barstow, California.

The White Dollar is a small tungsten mine which yielded a few hundred tons of ore when briefly operated early in 1951 and from February to June 1952. Some of the ore is reported by the lessees to have assayed 1.4 percent WO_3, but the average grade was probably less than 1 percent WO_3.

Scheelite is irregularly disseminated in brecciated, friable, garnet-epidote rock along a shear zone in shattered meta-volcanic rocks. The zone strikes N. 10° to 20° W. The shear zone has been explored for over 500 feet by open cuts and a shallow shaft, inclined 50° SW. About 200 feet west of this shaft a parallel zone was explored by a short open cut, ending in a nearly vertical underhand stope 6 feet wide, 20 feet long and about 30 feet deep.

Ore produced during 1951 was hauled to a custom mill in Randsburg. Ore being produced in 1952 was milled at both the Jaylite and the Parker mills in Barstow.

Uranium

No uranium deposits of proved commercial interest have been discovered in San Bernardino County. Pitchblende has been recognized in the Scotty Wilson deposit described in the lead-silver-zinc section herein. Traces of carnotite have been noted, here and there, in Tertiary sedimentary rocks.

Vanadium

Although the occurrence of vanadium minerals has been known in San Bernardino County, principally in the Camp Signal district north of Goffs, no successful commercial recovery of vanadium has been made.

In the Camp Signal district, vanadium occurs as vanadinite and thin coatings of cuprodescloizite in the seams and cracks of quartz veins in granitic rocks. The Louisiana-California Company and later the California Comstock Gold Mines, Ltd., made unsuccessful efforts to recover these minerals. Vanadium occurrences are noted in the tabulated list.

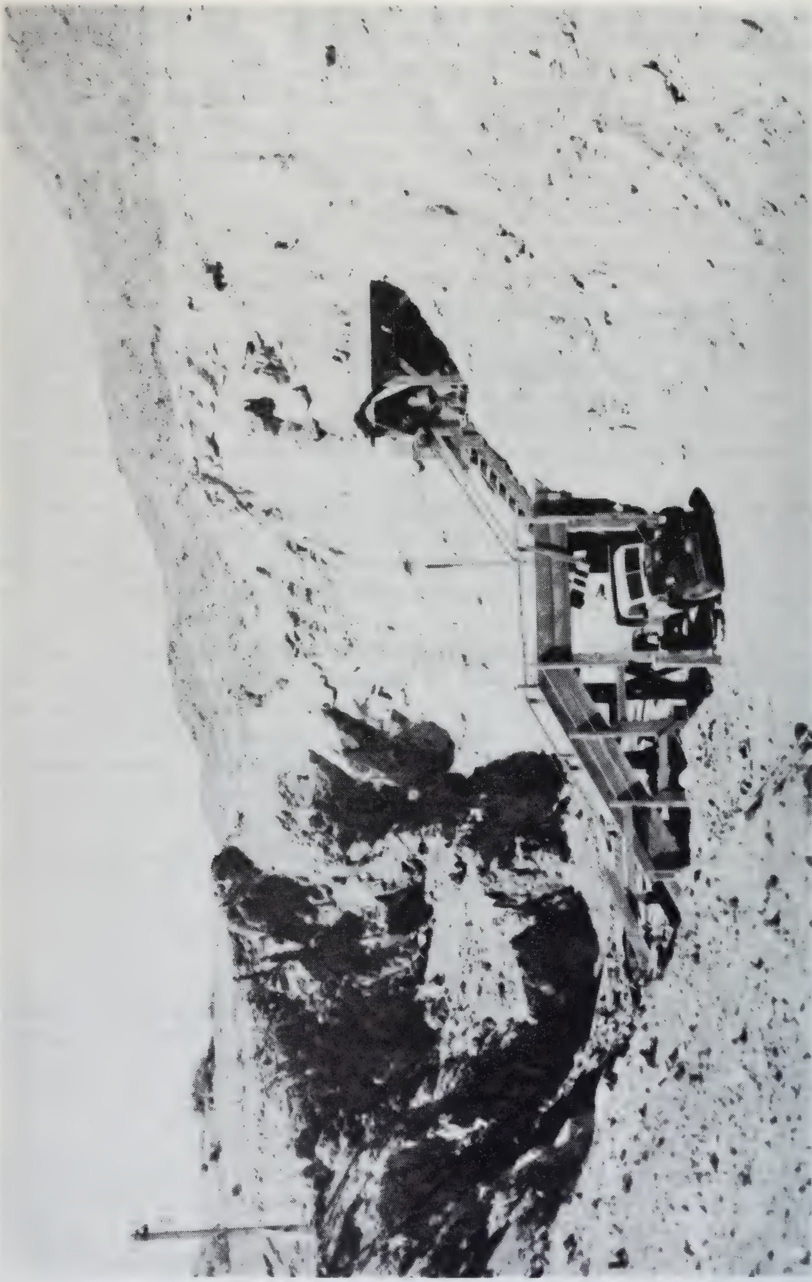

Figure 22. Starbright tungsten mine northeast of Barstow. The deposit, a scheelite-bearing tactite body in quartz diorite, was formerly worked by open pit, later by shaft inclined to left.

Nonmetals

Asbestos

The production of asbestos in San Bernardino County has been limited to a small tonnage of the amphibole variety obtained from the Golconda deposit (described below) in 1943. Crysotile asbestos has been noted at the Cronese deposit east of Soda Lake but probably is not of commercial interest.

Golconda (Hicks) Asbestos Deposit. Location: sec. 36, T. 9 N., R. 4 W., S.B.M., in the low hills about 3 airline miles west of Hodge, and 15 airline miles southwest of Barstow. Ownership: W. E. Leahy, 4238 Edgehill Drive, Los Angeles, California, holds patent to sec. 36, and is leasing the asbestos property to Pacific Petro-Chemical Corporation, 20700 South Figueroa Street, Torrance, California, Charles J. Gosselin, secretary.

The Golconda deposit contains asbestiform tremolitic amphibole, a small tonnage of which was mined in early 1943. In May 1952 the deposit was being explored.

The asbestos is associated with quartz sericite schist, and occurs in small veins through zones as much as 5 feet wide. Fibres are as much as 2 inches long, but are not of uniform length or orientation.

The eastern end of the zone has been explored by two partly filled shafts now 25 and 45 feet deep on two asbestos zones about 150 feet apart. The surface was being scraped bare of soil preparatory to commencing mining in 1952. About two-thirds of a mile west of this spot, along the strike of the schistosity, two caved pits and an abandoned vertical shaft over 100 feet deep mark the site of a former operation.[143] The geologic and mineralogical environment is identical to that described above.

The present lessee plans to mine the deposit by open cut methods and use the asbestos-bearing schist in structural blocks. A portable mill consisting of jaw crusher, bucket elevator, and triple-deck shaker screens was being installed on the property in 1952.

Barite

Although barite occurrences are widespread in San Bernardino County and several deposits have been mined, none has supported a continuing operation. Barite deposits were actively worked in the periods 1910-12 and 1929-37, and have been confined to the Grapevine, Calico, and Lavic districts. At least one operator recovered barite from mill tailings in the Calico district. Recently, interest has been shown in the recovery of barite as a by-product in the Mountain Pass rare earth operation. Barite-bearing properties are tabulated at the end of this report.

Clays

Clays of various types have been produced in San Bernardino County. The principal source of clay for ceramic use has been the Hart area, discussed below. Smaller amounts of ceramic clay have been mined intermittently in the Oro Grande area north of Victorville. Bentonite and hectorite have been mined principally from the Hector area. Smaller tonnages of bentonite have been obtained from deposits north of Randsburg. Lake bed silt has been used for oil well drilling mud and impermeable linings for canals and reservoirs.

[143] Tucker, W. B., and Sampson, R. J., op. cit., 1943.

Clay Deposits of the Hart Area, Castle Mountains

Since the early 1920's ceramic clay has been mined from deposits in an area low on the southwest slope of the Castle Mountains, and near the old Hart townsite. Here the layered Tertiary rhyolites that underlie the mountains contain extensive zones of hydrothermal alteration. The rhyolites strike northward and dip 15° to 30° westward. The most intensive alteration has followed steeply dipping to vertical fractures. The alteration product has been described as a ball clay [144]; much of it has been said to be a montmorillonite.

The zones range from a few feet to several hundred feet wide and are probably as much as 1000 feet long. Exposures of the altered rock are commonly obscured by a thin alluvial cover, but reserves appear to be very large. Although the altered zones are clay-rich, they also contain abundant residua of partly altered to relatively fresh rhyolite which in mining and processing are commonly mixed and ground with the clay as part of the commercial material.

In 1920, clay alteration rock, noted in the Oro Belle gold mine near Hart, was tested for its ceramic properties. Soon afterward quarries were opened at two nearby localities, but the clay was not mined in quantity until the early 1930's when it was found particularly useful in wall tile bodies containing a high proportion of talc. A third quarry, on the Oro Belle property, was opened late in 1951. Approximately four-fifths of the yearly output is now employed in wall tile manufacture; the remainder is used as a raw material in pottery and sanitary ware.

Active mining at each quarry is confined to a few weeks of each year. The clay-bearing rock is blasted from the quarry walls. The commercial material is separated from waste by bulldozer and moved to layered stockpiles. When shipped, it is cut in vertical slices from the stockpiles and placed on trucks by automatic loaders. It is hauled to a rail siding at Ivanpah and thence by rail to grinding mills in the Los Angeles area.

C. and M. Deposit. Location: sec. 19, T. 14 N., R. 18 E., on west slope of Castle Mountains, one-half mile east of old Hart townsite; on property of Oro Belle gold mine. Owner: W. W. Hartman, 1230 E. 109th Street, Los Angeles, California. Lessees: S. E. Chiapella, 1625 North Las Palmas Avenue, Los Angeles, California; and L. M. Moon, 4367 Sepulveda Boulevard, Sherman Oaks, California.

The C. and M. clay deposit, in general, is similar to the C-1 Hart and P. S. Hart deposits nearby. In excavations that began in December 1951 a 150- by 300-foot area of clay-bearing rock has been uncovered. The deposit is probably much more extensive. In mid-1952 clay was being removed from a quarry about 50 feet in diameter and about 15 feet in maximum depth.

C-1 Hart (Coors) Quarry. Location: secs. 18 and 19, T. 14 N., R. 18 E., S.B.M., at old Hart townsite, about 12 miles east-southeast of Ivanpah. Ownership: Southern California Minerals Company, 320 South Mission Road, Los Angeles, California, owns eight patented claims.

This quarry was opened in 1921 by H. F. Coors who was operating a porcelain factory in Inglewood. The product's first trade name, "Coors Clay No. 1," was later shortened to "C-1" clay, the name now used.

[144] Dietrich, W. F., The clay resources and the ceramic industry of California: California Div. Mines Bull. 99, p. 194, 1928.

The property yielded only a few hundred tons until acquired by the present operator in 1932. By the end of 1951 its output totaled about 92,000 tons. This has been obtained from a pit about 400 feet long, from 150 to 200 feet wide, and from 30 to 45 feet deep. To the west the deposit is flanked by a progressively thicker alluvial cover which probably overlies relatively unaltered rhyolite. Large reserves of clay, however, appear to exist east of the quarry and beneath the quarry floor.

P. S. Hart (Gladding McBean, Standard Sanitary) Quarry. Location: sec. 19, T. 14 N., R. 18 E., S.B.M., on the west slope of a hill about one-half mile south of Hart townsite and 12 miles east-southeast of Ivanpah. Owner: Gladding McBean and Company, 2901 Los Feliz Boulevard, Los Angeles, California, owns three patented claims.

The P. S. Hart property, formerly owned and operated by the Standard Sanitary Company, was purchased by the present owner in 1941, and furnishes a continuing supply of clay to the Gladding McBean plant in Glendale. Its total output is probably more than 50,000 tons. In early operations clay was removed by a series of low-angle stopes driven eastward into the hillside beneath a layer of relatively unaltered rock. Beginning in 1948 open-cut benching has been employed. In early 1952 the quarry had been driven parallel to the hillside for about 500 feet and inward from the original surface for about 400 feet. The quarry top is about 70 feet above the lowest point on the floor. The waste is removed by bulldozer beyond the quarry limits.

Clay Deposits in Other Areas

Hector Bentonite Deposits (California Talc Company's Bentonite Deposits and Eyrite or Ewrite Deposit). Location: sec. 31, T. 9 N., R. 5 E., and secs. 6, 22-27, 35, T. 8 N., R. 5 E., S.B.M. The deposit in T. 9 N. is about three miles west of Hector; those in T. 8 N., including the Eyrite deposit, are three to four miles south of Hector. Ownership: National Lead Company, Baroid Sales Division, 830 Ducommun Street, Los Angeles, California, owns fourteen 160-acre placer claims. The Eyrite (Ewrite) deposit, two 160-acre placer claims, owned by Oscar H. Hoerner and associates, Newberry, California, leased to Baroid Sales Division.

The Hector Bentonite properties contain a large portion of the most important known California deposits of colloidal, gel-forming type of bentonitic clay. The deposits have been exploited, almost continuously since 1931, from several shafts and open pits along a strike length of over 6700 feet. Production from part of the now-idle old workings is reported to have been 25,000 tons.[145] From 1947 to 1951 the workings on the Eyrite lease have produced more than 10,000 tons.

The material from these deposits is a waxy, white to light-colored mineral having a high magnesium content. It has been called saponite,[146] but the name hectorite was proposed by Strese and Hofmann in 1941 [147]

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[145] Tucker, W. B., op. cit., p. 253, 1940.
[146] Murdoch, Joseph, and Webb, R. W., Minerals of California, California Div. Mines, Bull. 136, p. 266, 1948.
[147] Strese, H., and Hofmann, Ulrich, Synthesis of magnesium silicate gels with two-dimensional structure: Zeitschr. anorg. allg. Chemie, vol. 247, p. 65, 1941. Abst. in Chem. Abst. vol. 36, p. 5074, 1942.

FIGURE 23. View east toward C. and M. clay quarry on property of Oro Belle gold mine in the Castle Mountains. Area of photo underlain by Tertiary acidic volcanic rocks locally altered to clay.

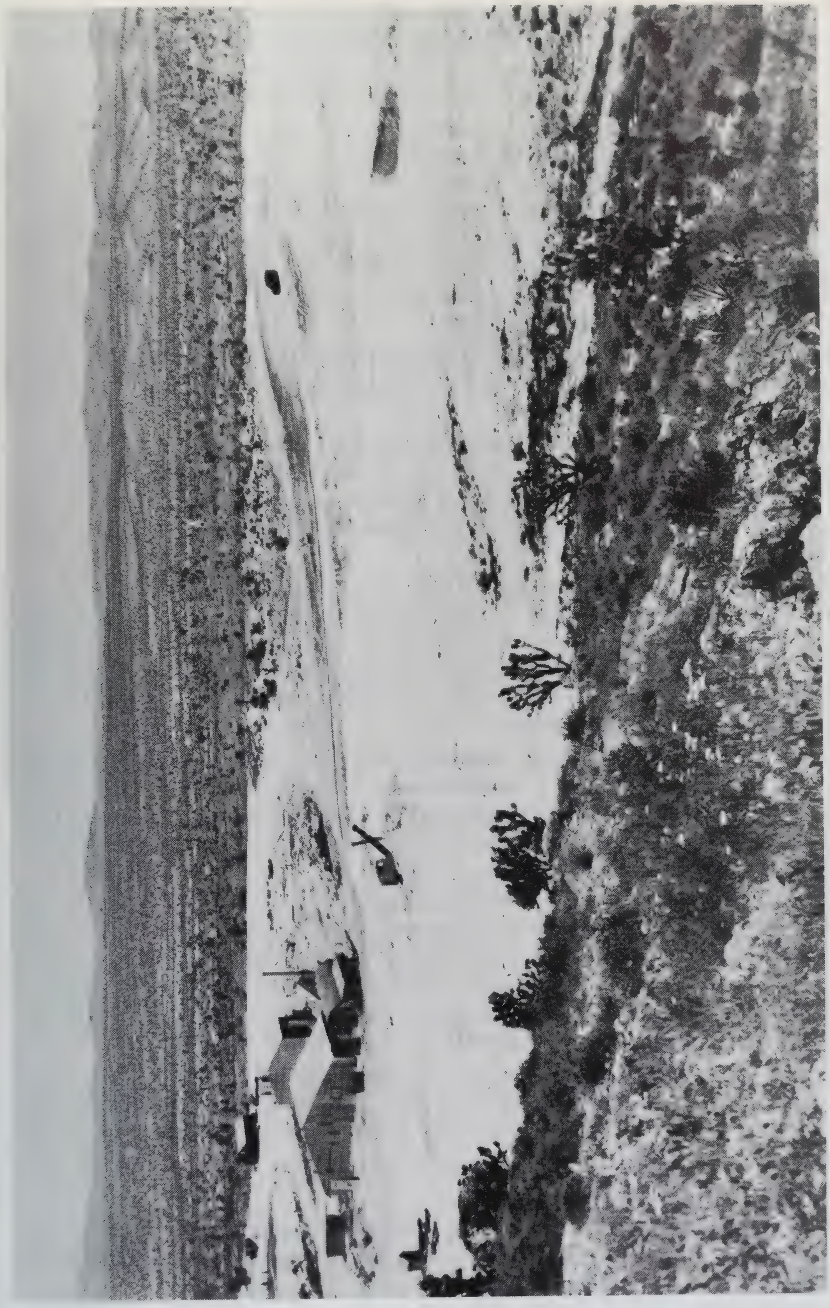

FIGURE 24. View northwest toward C-1 Hart clay quarry in Castle Mountains; operated by Southern California Minerals Company. Pit area is underlain by Tertiary rhyolite partly to wholly altered to clay.

and has since been generally accepted. An analysis given by Ross [148] shows, in part, 55.86 percent silica and 25.03 percent magnesia. Thus it differs chemically from the Wyoming bentonite, which is chiefly silica and alumina but has nearly the same physical characteristics.

Hectorite occurs in folded sedimentary rocks that are part of a Tertiary volcanic series.[149] The deposit has a northwesterly strike and a southwesterly dip ranging from 12° to 20°. The rocks have been eroded and unconformably overlain by alluvium and, in the southern deposits, by Recent basalt flows. The alluvium is as thick as 50 to 60 feet in some places. Limestone is generally the underlying rock, although Scott [150] reports that the hectorite bodies rest upon granite in some places and sandstone in others.

Kerr [151] considers the hectorite to have probably been derived from the alteration of basic volcanic ash, although it is possible that the parent rock could have been a flow.

Material of a commercial grade is found as lenses or pockets, which range in size from a few tons to many thousand tons.[152] The thickness of these lenses generally ranges from 4 to 12 feet, but a maximum of 40 feet has been reported; no attempt is made to mine any less than four feet thick.

Hectorite was formerly mined from workings appended to shafts inclined to follow the dip of the footwall to a depth of 300 feet. Open pits were also used, the largest of which reached a depth of 50 feet. Hectorite is now being mined from the Eyrite property (sec. 35) where a vertical shaft, 107 feet deep, has level workings at 40 and 70 feet. The 70-foot level is the main working level.

Hectorite contains up to 30 percent water when mined. It is hauled to a drying area at Hector and air-dried to about 10 percent moisture. When dried it is usually bulk-loaded into railroad cars for shipment to the company's grinding plant in Los Angeles. The mine plant includes a laboratory for control work.

The grade of the hectorite is determined in part by the number of barrels of oil-well drilling mud of desired viscosity that can be obtained from a ton of ore. Most of the hectorite is rated at 100 barrels or better. Special material having a very high magnesium content is sold for purposes other than drilling mud. Hand-sorted, white, waxy hectorite is used by the company for the manufacture of special products.

Inerto Company Hectorite Deposit. Location: secs. 27, 28, 34, and 35, T. 8 N., R. 5 E., S.B.M., about 4 miles south of Hector and adjoining the Eyrite deposit on the west. Ownership: Inerto Company, 1489 Folsom Street, San Francisco, California, owns the NE¼ sec. 28, SW¼ sec. 27, N½ sec. 34, and W½ sec. 35.

The Inerto Company has been mining hectorite from this deposit since about 1946, and at a rate of 250 to 300 tons per year. The deposit is an

148 Ross, C. S., and Hendricks, S. B., Minerals of the montmorillonite group: U. S. Geol. Surv. Prof. Paper, 205-B, Table 4, p. 35, 1945.

149 Kerr, Paul F., and Kulp, J. L., Hectorite, Hector, California: American Pet. Inst. Proj. 49, Clay mineral standards, Prelim. Rept. no. 2, Reference clay localities—United States, pp. 74-76, 1949.

150 Scott, R. E., Jr., Bentonite, in Tucker, W. B., op. cit., p. 251, 1940.

151 Kerr, Paul F., and Kulp, J. L., idem.

152 Scott, R. E., Jr., idem, p. 252.

extension of the deposit being mined by the National Lead Company, which is described above. The mine openings consist of an inclined shaft and a series of appended drifts and cross-cuts following the ore at an approximate depth of 60 feet.

The mine-run material has been hand sorted, and only the highest grade hauled to Hector for rail shipment. The company built a mill at Newberry in early 1952 for the beneficiation of mine-run hectorite which contains as much as 30 to 60 percent finely divided calcite, dolomite, or other impurities. Hectorite will be crushed in a hammer mill to minus 8-mesh, made into a gelled slurry in two wooden agitator tanks and, in a batch process, put through a centriclone to remove the impurities. The cleaned hectorite will go to a steam-heated, double-drum, rotary dryer yielding a thin cake of dried material which is to be marketed as ''macaloid''. Planned mill capacity is about 300 to 400 pounds of refined hectorite per hour.

Pacific Bentonite Mine. Location: sec. 29, T. 28 S., R. 41 E., M.D., in north-central part of Shadow Range, one mile west of the Johannesburg-to-Trona highway, and about 6½ airline miles northeast of Johannesburg, California. Ownership: Luis Martinez, Red Mountain, California, owns five claims and one fraction.

Several thousand tons of bentonite have been obtained in discontinuous operations at the Pacific mine, which was opened in 1931 by the present owner. The bentonite exists as layers in a belt of deformed Tertiary sandstones, siltstones, and volcanic rocks. Virtually all of the output of the Pacific mine appears to have been obtained from a single layer, which, where exposed, is from 4 to 13 feet thick. The layer strikes west, dips moderately north, and consists of a pale greenish-yellow bentonite. It is bordered, top and bottom, by sandstone and siltstone with pebbly layers.

Three shafts, all within a one-fourth mile segment of the layer, comprise the principal workings. The shafts are inclined northward at angles of 30° to 50°, and from west to east, are 100 feet, 100 feet, and 150 feet deep, respectively. At the 100-foot level of the most westerly shaft, drifts extend 75 feet westward and 125 feet eastward. The center shaft is caved within 15 feet of the surface. The most easterly shaft has three 75-foot, east-trending drifts, one each at the 50-, 100-, and 150-foot levels.

The bentonite has been trucked 6 miles to Searles Station on the Southern Pacific Railroad and thence moved to grinding plants in the Los Angeles area. It has been marketed mainly as a water impedient beneath reservoirs and canals, and as a constituent of cleansing preparations, less abundantly as drilling mud and foundry sand binder.

Dimension Stone

Since the late 1800's stone for use in the building and monument industries has been obtained from small quarrying operations in San Bernardino County. All have operated briefly or intermittently. Before the advent of modern paving techniques, curbstones and paving blocks also were produced at several quarries. The county's dimension stone industry has centered about the Victorville-Oro Grande-Lucerne Valley region where Mesozoic quartz monzonite is exposed in bodies that are more uniform in composition, less weathered, and less fractured than most

other accessible occurrences of granitic rocks in the Transverse Ranges and Mojave Desert.

Dimension stone also has been obtained from sandstone quarries on Mill Creek in the San Bernardino Mountains and another in the Ivanpah Mountains, from quartzite talus slopes near Baldwin Lake, and from several marble quarries, at Slover Mountain near Colton, the Three Color quarry northeast of Victorville, and the Vaughan quarries near Cadiz. Verde antique also has been obtained northeast of Victorville. Dimension stone was most actively quarried in San Bernardino County during the period 1880-1900, and was used in the construction of buildings throughout California. The industry declined with the increased use of concrete and terra cotta in construction.

Delfante Sandstone. Location: sec. 25 (approx.), T. 16 N., R. 13 E., S.B.M. (projected), about 3 airline miles southeast of Mountain Pass and about 33 airline miles east of Baker. Ownership: Jack Delfante, Las Vegas, Nevada, and Frank Rathbun, Wheaton Springs, Nipton P. O., California, own three unpatented placer claims.

The Delfante quarry is a small sandstone quarry from which several hundred tons of dimension stone were removed in 1951, the first year of operation. The quarry is in the Navajo sandstone, a Jurassic (?) formation [153] exposed on the east side of the Mescal Range.

The rock is an evenly banded, fine-grained sandstone, mostly brick red in color and weathering from pale yellow to pale red. The sandstone strikes northeast, dips gently northwest, is several hundred feet thick, and is exposed laterally for several thousand feet.

Stone has been removed from three pits 10 to 15 feet deep within an area about 800 feet square on a low ridge. The rock has been drilled, blasted, split into slabs and trimmed on the property. Finished rock has been trucked to the Long Beach area and marketed as facing, flagstones and structural pieces. In mid-1952 the property was idle.

Gold Mountain Quartz (Ornamental Stone) Quarry. Location: secs. 6 and 7, T. 2 N., R. 2 E., and secs. 1 and 12, T. 2 N., R. 1 E., S.B.M., near the west shore of Baldwin Lake and about 1½ miles east-northeast of Big Bear City. Ownership: Alford Coleman, 661 West 27th Street, San Pedro, California, owns 14 placer claims.

The Gold Mountain claims were located during the period 1949-51 on an area underlain by outcrops and talus of the Saragossa quartzite, a Paleozoic formation extensively exposed in the eastern part of the San Bernardino Mountains. For many years this quartzite, obtained from slopes on the south flank of Gold Mountain, has been used as ornamental stone in the Big Bear Lake region. The present operation is aimed at markets in the Los Angeles area as well, but shipments through 1951 were small. The rock is also sold as terrazzo and aggregate material. It is recovered from talus composed of blocks and slabs of various shapes and dimensions and is sold generally untrimmed. The fresh quartzite is nearly white but most of the material mined is stained to shades of red, orange and lavender. Early in 1952 development consisted chiefly of access roads.

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[153] Hewett, D. F., personal communication.

Swanson Granite Quarries. Location: secs. 30 and 31, T. 5 N., R. 2 E., and sec. 36, T. 5 N., R. 1 E., S.B.M., about 1½ miles southwest of the Texas granite quarries, and about 8 airline miles east-northeast of Lucerne Valley settlement. Owner: Clara Swanson, Victorville.

A small tonnage of granitic dimension stone has been removed from two quarries on the Swanson property. The quarries, about one-fourth mile apart, are in rock similar in character and occurrence to that at the nearby Texas quarries described below. The output has been shipped to finishing plants in Victorville and Los Angeles.

Texas Granite Quarries. Location: sec. 29, T. 5 N., R. 2 E., S.B.M., about 2½ miles northwest of Negro Butte, and about 10 miles east-northeast of Lucerne Valley settlement. Ownership: W. H. Johnson Company, Victorville, California owns eight claims.

The two small workings, known as the Texas granite quarries, were opened in the mid-thirties and have intermittently yielded granitic dimension stone for use in buildings and monuments. The quarries, about 1500 feet apart, are in a group of rugged, north-trending hills composed almost wholly of the granitic rock. Jointing, ordinarily in three sets at nearly right angles to each other, has formed large blocks, many with dimensions of 10 to 30 feet.

The granitic rock, a biotite-rich quartz-monzonite of probable Mesozoic age, is pale gray to pale yellowish gray, medium-grained, and devoid of pronounced linear or planar structures. Weathering has commonly produced concentric iron oxide bands parallel with the jointing, an effect particularly well-shown in the southern quarry where dimension stone known as "golden vein" granite is produced.

Quarrying has been confined to the large, relatively fresh blocks. These have been split parallel with the jointing. Both quarries are about 200 feet long, 100 feet wide and have faces from 20 to 40 feet high. The rock is hauled by truck to a finishing plant in Victorville.

These and other granite sources, in the Stoddard Well and Baker areas, are worked for 2 or 3 months each year. In December 1950 stone from the Texas quarries was being fabricated for use in University of California buildings at Los Angeles and La Jolla.

Feldspar

The feldspar produced to date in San Bernardino County probably totals from 17,000 to 18,000 tons of which all but a small fraction has been obtained from the White Butte deposit described below. Deposits that have yielded very small tonnages include the Keystone and Lucky Jim near Lake Arrowhead, and the Sloan 3½ miles north of Hinkley.

As elsewhere, the feldspar deposits of greatest commercial interest in the county exist in pegmatite bodies. Large pegmatite bodies, however, are uncommon in the Mojave Desert. Pods and tabular dikes of pegmatite, from a few inches to several feet wide, are abundant in several Archean terranes. A few bodies, including the White Butte, lie within Mesozoic granitic masses.

White Butte Deposit. Location: sec. 18, T. 31 S., R. 44 E., M.D.M., 9 airline miles east-northeast of Fremont Peak, and 18 airline miles east-

FIGURE 25. View east toward Swanson granite quarry northeast of Lucerne Valley.

southeast of Atolia. Ownership: Gladding McBean and Company, 2901 Los Feliz Boulevard, Los Angeles, California owns two claims.

The White Butte deposit has yielded about 17,000 tons of ceramic grade feldspar since it was opened in 1940. The deposit is a pegmatite body exposed on a low hill surrounded by alluvium. The pegmatite lies within Mesozoic quartz monzonite which is extensively exposed in the nearby hills.[154]

The pegmatite body appears to be a steeply dipping, west-trending pod. In plan it is about 200 feet in maximum width and at least 300 feet long. It is composed mostly of very coarse-grained, pale pink, perthitic microcline, but contains massive quartz pods, from a few feet to as much as 60 feet long. The pods are rather evenly distributed through the body. Quartz also occurs in veinlets. Minor constituents include biotite, sericite, and albite. More than two-thirds of the body appears to be nearly pure feldspar.

The workings consist of an open cut, irregular in outline, but about 125 feet wide, 200 feet long, and 30 feet in maximum depth. Remnants of the larger quartz masses remain in the cut. The feldspar has been employed as a ceramic raw material by Gladding McBean and Company.

Fluorspar

Fluorspar deposits have been prospected in at least 15 widely distributed localities in San Bernardino County. Two or three of the deposits have yielded a small tonnage of marketable fluorspar, but none has proved operable on a commercial scale.

Pertinent data on the deposits, as described in previous investigations, are contained in the tabulated list at the end of this report. The fluorspar of San Bernardino County generally occurs in veins that are either very small or that contain abundant impurities. Some of the veins are in dolomite, others are in volcanic rock, still others cut granitic rock. Rarely do individual veins exceed one foot in thickness or 100 feet in length.

Deposits 3 to 5 miles south of Afton, which have probably attracted the most interest, were worked briefly during World War I. Although these contain significant fluorite reserves, the smallness of individual veins has prevented a continuing operation. Relatively large quantities of fluorite also exist in the Clark Mountain area, but here it is intimately mixed with sericite and would require beneficiation.

Gem Stones

The gem mining operations of greatest commercial significance in San Bernardino County recovered turquoise from deposits widely scattered over three areas between Yucca Grove and Silver Lake. Though extensively mined by prehistoric Indians, who left many artifacts,[155] the deposits were not known to white men until the mid-1890's. They were extensively mined from 1898 until 1903 when the larger veins were believed exhausted.[156] Two companies were active; the Toltec Gem Min-

[154] Dibblee, T. W., Jr., unpublished geologic map of the Fremont Peak quadrangle.

[155] Heizer, R. W., and Treganza, A. E., Mines and quarries of the Indians of California: California Div. Mines Rept. 40, pp. 335-336, 1944.

Rogers, M. J., Report of an archeological reconnaissance in the Mohave sink region: San Diego Museum, Archeology, vol. 1, no. 1, 13 pp., 1929.

[156] Kunz, G. F., Gems, jewelers' materials, and ornamental stones of California: California Min. Bur. Bull. 37, pp. 107-110, 1905.

ing Company, which controlled 3 properties along a 9-mile belt, and the Himalaya Mining Company, whose mine was near the west end of the same belt.[157]

The turquoise occurs as abundant and widespread veinlets, smears, and disseminations in alteration zones within granitic rock. It is closely associated with alunite.[158] Commonly within the zones are quartz veinlets which much or all of the turquoise post-dates.

The deposits are said to have proved shallow, with no turquoise found deeper than 100 feet. There appear to be no proved reserves of gem-quality turquoise, but subcommercial occurrences can be observed in place, and turquoise chips are abundant on the mine dumps.

Graphite

Although there are several reported [159] occurrences of graphite in San Bernardino County, none has been operated. Probably the most extensive is the Big Bear deposit described below.

Big Bear Graphite Deposit. Location: secs. 28, 29, 32, and 33, T. 2 N., R. 2 E., S.B.M., in Green Canyon in the Big Bear Lake area of the San Bernardino mountains, about three airline miles south of Baldwin Lake. Ownership: Undetermined.

The Big Bear graphite deposit, which has never been placed in continuing operation, is a zone of graphitic schist bordered by the Saragossa (Paleozoic) quartzite.

The zone is as much as 150 yards wide for at least half a mile in exposed length. The zone strikes northeast and dips steeply northwest, but is highly deformed in its internal structure. From place to place the graphite varies in appearance. In its southerly exposures, a very hard black slaty habit predominates.

Exploration workings are confined chiefly to an area about 100 by 50 yards on a side, east of Green Canyon. Here the zone is exposed in a series of shallow pits, bulldozer cuts, and a single 15-foot adit.

Limestone and Dolomite [160]

On a value basis, about one-half of the total annual mineral yield of San Bernardino County is furnished by limestone operations. All but a small fraction of the limestone output is used by portland cement plants of which three, of the state's total of eleven, exist in San Bernardino County. Several limestone deposits are being worked for other purposes. The county also contains large undeveloped limestone reserves of various industrial grades. Some are accessible; others are too remote to be of present commercial interest. Dolomite deposits are likewise abundant and widespread, but a comparatively small demand has hindered their development on a scale comparable with the limestone operations.

Most of the limestone and dolomite in the county are in partly to thoroughly metamorphosed marine formations. At many localities these

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[157] See locations on accompanying map.
[158] Hewett, D. F., personal communication, 1951.
[159] Murdoch, Joseph, and Webb, R. W., Minerals of California: California Div. Mines Bull. 136, p. 163, 1948.
[160] Oliver E. Bowen, Jr., Associate Mining Geologist, California Division of Mines, has kindly supplied most of the data in the following general section on limestone, and the descriptions of the California Dolomite, California Portland Cement, Cave Canyon, Riverside Cement, Sheep Creek, Southwestern Portland Cement, and Victorville Lime Rock properties.

two carbonate rocks are intimately associated and show planar, interfingering, or irregular contacts. The carbonate-bearing units commonly also contain quartzite and mica schist and are complexly folded and faulted. Many of the deposits are intruded by granitic bodies of various sizes. In the southwestern part of the county most of the carbonate rocks are Upper Paleozoic in age. Elsewhere, the largest of the relatively undeveloped reserves exist in Algonkian and Cambrian formations.

The chief limestone-producing districts are at Colton, Victorville, Oro Grande and Chubbuck. Small tonnages are also produced at Wrightwood in the San Bernardino Mountains. In the past, deposits near Basin (Baxter), between Barstow and Baker, were rather extensively mined. From time to time small limestone quarries in the northeastern part of the San Bernardino Mountains, in the Lucerne Valley area, and in the New York Mountains, also have been worked. Dolomite, used in white and yellow roofing granules, is quarried in the northeastern part of the Shadow Mountains between Adelanto and Kramer. Small tonnages of dolomite have been mined in the Chubbuck and Hinkley areas for use in the Kaiser Steel Corporation's plant at Fontana.

In the Victorville-Oro Grande district, where most of the limestone is now obtained, carbonate bodies occur in the Oro Grande series, which is predominantly Carboniferous, and in the Permian Fairview Valley formation. The carbonate units are commonly several hundred feet thick and several thousand feet in exposed length. They exist as resistant rocks forming prominent ridges. In the Oro Grande series crystalline limestone members are interbedded with thick members of quartzite and mica schist which, in some areas, comprise an overburden and handicap quarrying operations. Crystalline limestones of the Oro Grande series are medium- to coarse-grained and vary from white to dark blue-gray. The principal industrial limestone in the Fairview Valley formation is found in the upper part of the section. It is a blue-gray, coarse, well-cemented conglomerate in which all but a small percentage of the matrix, cobbles and boulders, which comprise the rock, is limestone. There is little or no overburden on the Fairview Valley limestone conglomerate, but it crops out on very rugged topography.

The limestone deposits closest to the Los Angeles industrial area are those of the eastern Jurupa Mountains in the Riverside-Colton district. They support one cement plant at Colton, San Bernardino County, and one at Crestmore, Riverside County. The limestone, as exposed in a group of hills, occurs as roof pendants in granitic rock and, at some localities, is interbedded with dolomite and mica schist. The limestone appears unfossiliferous, but has been tentatively classified as of Paleozoic or Triassic age.[161] It is mostly coarse-grained. Although locally silicated, it is ordinarily quite pure. Much of the rock quarried at Slover Mountain (Colton) and Crestmore contains more than 99 percent $CaCO_3$. The rock ranges in color from white to bluish gray.

The limestone deposits west of Chubbuck in the eastern part of the county have been quarried intermittently for many years. They are

[161] Woodford, A. O., Crestmore minerals: California Div. Mines Rept. 39, pp. 333-365, 1943.
MacKevett, E. M., Geology of the Jurupa Mountains, Riverside and San Bernardino Counties, California: California Div. Mines Special Rept. 5, 1951.

FIGURE 26. View east toward plant and quarry of California Portland Cement Company, Slover Mountain, west of Colton.

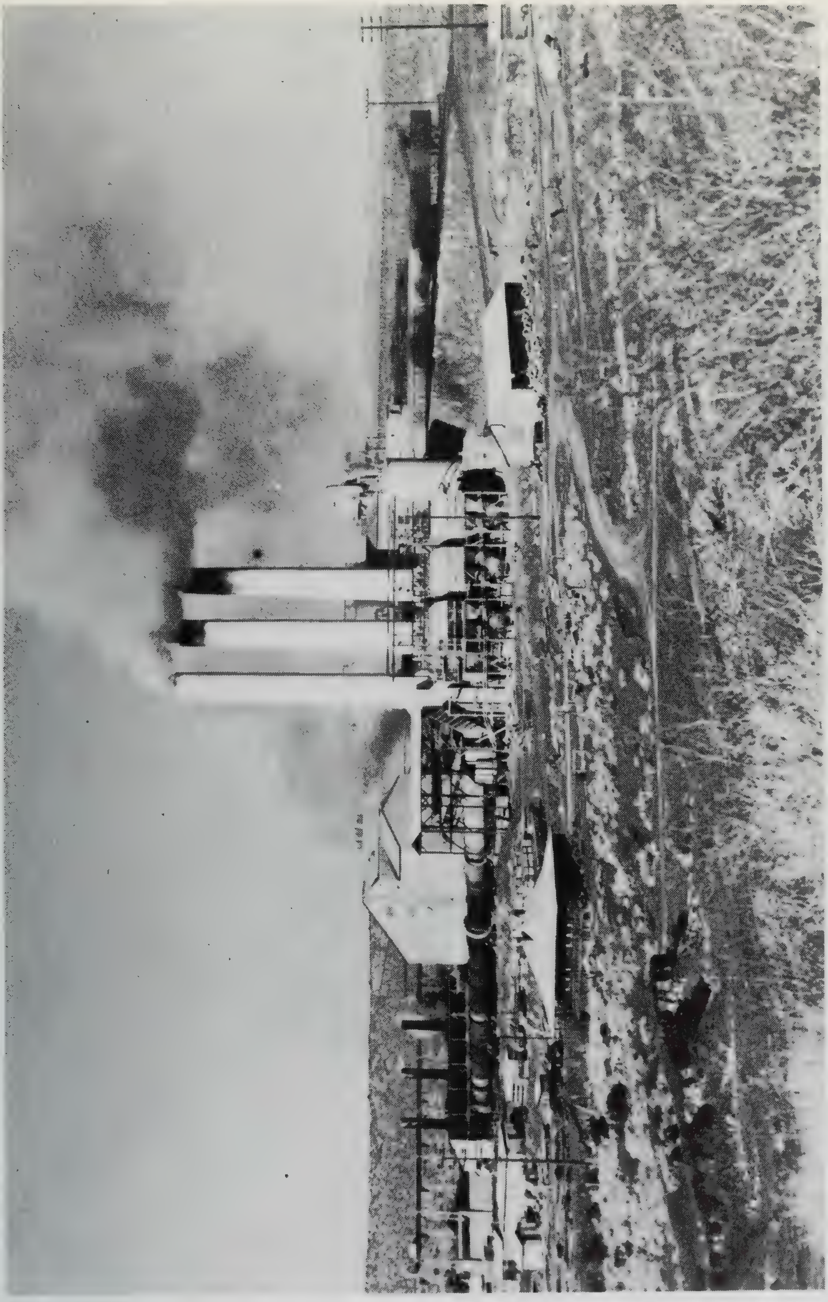

FIGURE 27. View east toward Riverside Cement Company plant at Oro Grande.

part of the Essex series of probable pre-Cambrian age,[162] are highly contorted, and are interbedded with quartzite and quartz-mica schist. The limestone ranges from coarse- to fine-grained and is white to cream in color. Selected material averages more than 99 percent $CaCO_3$, but care in mining is necessary to assure such purity. Most of the limestone masses dip steeply and have little or no overburden.

In recent years Carboniferous dolomite and limestone in the Marble and Bristol Mountains north of Cadiz and Chambless have been quarried. The limestone and dolomite in this area are interbedded and are white to blue-gray and medium- to coarse-grained. They are extensively exposed, and strongly folded. Much of the limestone averages 97.5 percent $CaCO_3$. Much of the dolomite contains 97 percent calcium and magnesium carbonates and averages about 20 percent MgO and 31 percent CaO.

Small tonnages of limestone are mined in an area between Wrightwood and Cajon Pass in the eastern San Gabriel Mountains. Here the limestone occurs as a series of roof pendants in granitic rock. The pendants lie along a west-trending belt about half a mile wide and 12 miles long. Some of the masses are highly fractured, and most are intruded by numerous granitic dikes. Most of the limestone is milky white and well suited for white roofing granule material. Chemical analyses show a calcium carbonate content of 91 to 97 percent; silica from 1 to 5 percent; the magnesia from 2.1 to 3.2; and iron and aluminum oxides from 0.2 to 1.6 percent.

Very large reserves of limestone suitable as industrial material exist in the Cushenbury Canyon area in the northeastern San Bernardino Mountains. These are only a few miles farther from Los Angeles marketing centers than deposits in the Victorville-Oro Grande district, but are 25 to 30 miles east of the Santa Fe Railroad. Rock has been mined intermittently in the past for use in sugar refining. Much of the rock is a tectonic breccia occurring in fault blocks, but there are large areas of relatively unbroken massive limestone and dolomite. The limestone crops out on very rugged topography and there is usually no overburden. The geology of the area has been discussed by Woodford and Harris,[163] by Vaughan,[164] and by Guillou.[165] The rock is medium-grained, commonly sugary and blue-gray to white. The chemical composition of much of the limestone in Cushenbury Canyon falls within the following limits:

$CaCO_3$	91.4-98.7%
$MgCO_3$	.8- 1.9%
Insoluble	.4- 6.8%
$(Fe,Al)_2O_3$	1.0%

Large areas covered by carbonate formations are also known in the Ivanpah Mountains north of Cima, in the Clark Mountains east of

[162] Hazzard, J. C., and Dosch, E. F., Archean rocks in the Piute and Old Woman Mountains, San Bernardino County, Calif. (abs.): Geol. Soc. America Proc., 1936, pp. 308-309, 1937.

[163] Woodford, A. O., and Harris, T. A., Geology of Blackhawk Canyon, San Bernardino Mountains, California: Univ. California Dept. Geol. Sci. Bull., vol. 17, pp. 265-304, 1928.

[164] Vaughan, F. E., Geology of San Bernardino Mountains north of San Gorgonio Pass: Univ. California, Dept. Geol. Sci. Bull., vol. 13, pp. 319-411, 1922.

[165] Guillou, Robert, Geology of the Johnston Grade area, San Bernardino Mountains, California: Univ. California at Los Angeles, Masters thesis, unpublished.

Baker, in the mountains both east and northwest of Kelso, in the Cave Canyon district near Baxter near Lone Mountain north of Barstow, and in the Shadow Mountains northwest of Adelanto.

California Portland Cement Company (Colton, Slover Mountain) Deposit. Location: secs. 19 and 30, T. 1 S., R. 4 W., S.B.M., on an isolated hill on the southwestern edge of the town of Colton. Owner: California Portland Cement Company, 612 South Flower Street, Los Angeles, California.

Of the large bodies of high-grade limestone in southern California, the deposit at Slover Mountain is the closest to the Los Angeles industrial area. It has been worked almost continuously since 1894 when it was acquired by the present owners. The product has been used mainly for portland cement, but also for steel flux, glass and other purposes. Prior to 1894 it was used intermittently for lime. In spite of its long record of production, the Slover Mountain limestone deposit is far from depleted, even though it is being quarried at the rate of about 1½ million tons annually. The mountain is still 500 feet high and approximately half a square mile in plan.

The limestone, part of a roof pendant in granodiorite, is regarded as Upper Paleozoic by some geologists and Triassic by others. The rock, much of which exceeds 99 percent $CaCO_3$, ranges from a coarsely crystalline, white variety to a finer-grained, blue-gray to white variety. A blue-gray to white, banded rock is prominent in the northeastern part of the deposit. Small, disseminated flakes of graphite are widespread, but in minor proportion. Also present are small, contorted lenses of mica schist.

The limestone strata, which are poorly defined, strike north to northeast and dip 40° to 45° east. They are more than 2000 feet in exposed thickness. The northwestern part of the hill is cut by dikes composed variously of aplite, pegmatite and granodiorite, and ranging from a few inches to six feet wide. Their presence does not present a serious mining problem. As the granodiorite contains less than 5 percent alkalies, it is used as the aluminous and siliceous fraction of the cement. Quartzite from Oro Grande, hematite iron ore from the company's Cave Canyon deposit, and gypsum from Nevada are also used as cement constituents. A dry-process plant on the property has an annual rated capacity of 5,000,000 barrels. The company also makes high-calcium lime and sells crushed limestone for various purposes, including glass manufacture, poultry grit, and cattle feed.

Limestone is currently being quarried from the southern and western flanks of the mountain in benches spaced at 50- to 200-foot vertical intervals. Rock is broken by blasting from drill holes sunk roughly parallel to the face and from coyote holes driven perpendicular to the face.

California Dolomite Company Deposits. Location: sec. 32, T. 8 N., R. 6 W., S.B.M., in northeast part of Silver Peak, 14 airline miles north of Adelanto and 2 miles west of U. S. Highway 395. Owners: Nicholas Baxter and Norris Williams, Adelanto, California. Lessee: California Dolomite Company, Incorporated, 10019 East Park, Bellflower, California.

The California Dolomite Company has been quarrying and milling dolomite in the Silver Peak area since late in 1950, and has marketed the

product as roofing granule material. The dolomite has been obtained from several quarries, within one mile of each other. They lie along a northeast-trending belt on the northeast slope of the peak.

The peak is underlain mostly by dolomite and limestone of the Oro Grande series. The two rocks are interbedded with each other. They range from white to dark gray and various shades of brown and from fine- to coarse-grained. The beds strike northeast and dip moderately to the northwest.

In general, the operators have sought the whitest rock, but a rust-colored grade is also marketed. Because of the interbedding, careful, selective mining is necessary. In mid-1952 the seventh quarry had been opened.

The mill, in the southwest corner of sec. 28, consists of a jaw crusher, roll crusher, and screens. Granules are produced in various sizes and shipped in 100-pound bags. They are marketed throughout southern California and as far north as Fresno. The mill has a rated capacity of 100 tons per day and, according to the operators, averages about 75 tons per day. About 12 men are employed.

Cave Canyon (Baxter and Ballardie, Evening Star, White Marble) Deposits. Location: secs. 11 and 12, T. 11 N., R. 6 E., S.B.M., about half a mile west of Basin, a siding on the Union Pacific Railroad. Owner: California Portland Cement Company, 612 South Flower Street, Los Angeles, California.

From 1906 to the early 1920's limestone for use as sugar rock was quarried from the Baxter and Ballardie deposits, then owned by D. F. and D. A. Baxter and A. W. Ballardie. Adjoining quarries were operated during part of the same period by Sugar Lime Rock Company of Los Angeles.[166] These old properties, together with adjoining land owned by the Southern Pacific Company, were acquired by California Portland Cement Company in 1930. The lands contain valuable iron ore deposits, as well as limestone. Their geological features have been briefly described by Hewett [167] and Lamey.[168]

The carbonate mass from which the limestone was mined underlies a low northeast-trending ridge about one mile long and one-fourth of a mile wide and from 200 to 400 feet high. The ridge marks the position of a complexly crenulated and faulted anticline.

The carbonate ridge is composed principally of white, coarsely crystalline limestone and dense, blue-gray, fine-grained, dolomitic limestone. The white rock has probably formed by recrystallization of the blue rock and is believed suitable for cement manufacture. It occurs in masses several hundred feet wide and 500 or more feet long. Less abundant is the limestone previously mined as sugar rock. It is a dense, fine-grained, pale yellowish-pink limestone occurring in beds that range in thickness from a few feet to a few tens of feet. From place to place on the ridge of carbonate rock, veins and irregular masses of dolomite and pods and veins of iron oxides have formed by replacement of the limestone. Cutting the carbonate units are dark dikes a few inches to a few

166 Cloudman, H. C., and others, San Bernardino County: California Min. Bur. Rept. 15, pp. 872-876, 1917.

167 Hewett, D. F., and others, Mineral resources of the region around Boulder Dam: U. S. Geol. Survey Bull. 871, p. 163, 1936.

168 Lamey, C. A., Cave Canyon iron ore deposits, San Bernardino County, California: California Div. Mines Bull. 129, pp. 71-83, 1948.

feet wide. The sugar rock was mined selectively from open cuts and loaded on railway cars at a spur extending from Basin.

Chubbuck (Chubbuck Lime Company, White Mountain Lime Company) Deposits. Location: secs. 10, 11, 15, 16, 21 and 22, T. 3 N., R. 16 E., S.B.M., extending two miles southwestward from Chubbuck, on a series of low parallel ridges at the north end of the Iron Mountains. Owner: Reconstruction Finance Corporation owns 1600 acres being purchased (1951) by the White Mountain Lime Company, Harms Brothers, 5261 Stockton Boulevard, Sacramento, California.

The Chubbuck limestone deposits were worked nearly continuously from 1925 through 1948 and intermittently from 1949-51. The total production of limestone has been about 500,000 tons. Two-thirds of this was used to produce approximately 165,000 tons of lime products; the other third was used directly for limestone products. The White Mountain Lime Company operated for a short time in 1951 and plans to continue.

Pendants of fine- to coarse-grained limestone are exposed on several low parallel ridges which trend north-northwest; dolomite is exposed on a ridge which is southwest of the other. The limestone and dolomite are part of the Chubbuck marble member of the Essex series (Archean) of metamorphosed sediments and minor amounts of altered igneous material.[169]

Four quarries, the largest of which were from 150 to 200 feet wide, 500 to 600 feet long and 30 feet in maximum depth, have been opened on the deposits. Only two quarries were operated by the White Mountain Lime Company. Trucks hauled the quarried limestone to a 120-ton crushing and screening plant which provided raw limestone for the lime products plant or produced crushed limestone in several commercial sizes.

Two sizes of crushed limestone, minus 1-inch plus $\frac{3}{8}$-inch and minus $\frac{3}{8}$-inch plus $\frac{1}{8}$-inch, were used as feed for the two kilns in the lime products plant. The capacity of these two 5- by 60-foot rotary kilns is 50 to 60 tons of lime per day. The kiln products were screened, and all minus 8-mesh material was further ground to minus 200-mesh.

Facilities were provided for sacking the lime products and some of the finer limestone products as well as for bulk loading into railroad cars.

Chubbuck Reserve (Chubbuck Limestone and Dolomite) Deposits. Location: secs. 17, 20 and 21, T. 6 N., R. 14 E., S.B.M., on the southwest slope of the Marble Mountains about 6 airline miles northward from Cadiz. Owner: Reconstruction Finance Corporation owns 1,120 acres being purchased (1951) by White Mountain Lime Company, Harms Brothers, 5621 Stockton Boulevard, Sacramento, California.

The Chubbuck Reserve limestone and dolomite deposits have been prospected and small amounts of rock mined for test purposes. An estimate of the limestone reserves as quoted by Tucker[170] is 100,000,000 tons. Logan[171] cites a private report in which a portion of these deposits

[169] Hazzard, J. C., and Dosch, E. F., Archean rocks in the Piute and Old Woman Mountains, San Bernardino County, California (abs.): Geol. Soc. America Proc. 1936, pp. 308-309, 1937.
[170] Tucker, W. B., op. cit., p. 518, 1943.
[171] Logan, Clarence A., Limestone in California: California Jour. Mines and Geol., vol. 43, pp. 284-287, 1947.

is estimated to have a recoverable reserve of 13,100,000 tons of white limestone and 34,800,000 tons of dolomite.

Beds of dolomite and white and blue limestone are a part of a metamorphosed sedimentary section of Paleozoic age.[172] White limestone, which constitutes the main mass of the deposit, forms a precipitous ridge about 700 feet high. The strike of the massive and obscure bedding is approximately N. 65° E., the dip ranges from 45° S. to 80° N. The dolomite beds form three ridges south of the limestone.

In 1943 the Kaiser Steel Corporation leased the property and drove an adit 106 feet into the limestone for the purpose of securing samples. During the same period 2,000 tons of dolomite was mined from a quarry bench and shipped to Fontana.[173] The property has been idle since.

Cushenbury Canyon (Dunton) Quarry. Location: secs. 10-16 inclusive, T. 3 N., R. 1 E., S.B.M., low on the east side of Cushenbury Canyon and about 2 miles south-southeast of Cushenbury Springs near the north base of the San Bernardino Range. Owner: Mineral Materials Company, 1145 Westminster Avenue, Alhambra, California own 25 claims.

The Cushenbury limestone quarry was opened in 1947, and operated intermittently and on a small scale until it was shut down in 1950. During this period the deposit yielded several thousand tons.

The quarry is in a layer of white, coarsely crystalline, and moderately friable limestone about 50 feet thick. The layer is a part of the Furnace formation (Mississippian?), a unit extensively exposed in the northeastern part of the San Bernardino Range. In the quarry area the formation strikes west to west-northwest and dips 45° to 55° south. The layer is bordered, top and bottom, by gray, fine-grained limestone; the underlying rock is siliceous. The quarry, which faces northeast, is about 80 feet high, 120 feet long, and has been worked inward for an average of about 20 feet from the canyon wall. Only a small fraction of the easily mined part of the layer has been removed.

The limestone was trucked to Thorn; from Thorn it was shipped by rail to the Los Angeles mill of the Kennedy Minerals Company where it was ground for use as whiting.

Hinkley Deposit. Location: secs. 11 and 12, T. 9 N., R. 4 W., S.B.M., 5 airline miles southwest of Hinkley, a station on the Santa Fe Railroad. Owner: A. R. Mills, 3859 Main Street, Riverside, California.

The Hinkley dolomite deposit was quarried briefly in the mid-1940's, as a source of raw material for the Fontana plant of the Kaiser Steel Corporation. A crushing and screening plant, erected on the property, has since been removed.

The dolomite occurs as a massive unit in a series of metamorphic rocks that also contains abundant schist and quartzite and is extensively invaded by granitic rocks. In the quarry area is a highly fractured body of dolomite at least 750 by 1000 feet in plan, and 100 or more feet thick. The dolomite is medium- to coarse-grained and pale yellow to white. It strikes northeast and dips steeply southeast. It contains several

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[172] Hazzard, John C., Notes on the Cambrian rocks of the eastern Mohave Desert, California: California Univ., Dept. Geol. Sci. Bull. vol. 23, pp. 57-70, 1933.

[173] Powell, K. B., personal communication, May 1951.

irregular dikes, mostly 6 to 20 feet wide, of quartz monzonite and hornblende diorite.

Ivanpah (O'Connell) Deposit. Location: sec. 9, T. 14 N., R. 16 E., S.B.M. (projected), near Slaughterhouse Spring low on the northwestern slope of the New York Mountains, and about 3 miles southeast of Ivanpah. Ownership: J. O'Connell, 437 North Oakhurst Drive, Beverly Hills, and S. E. Chiapella, 1625 N. Las Palmas Avenue, Los Angeles, California, own four claims.

The Ivanpah claims cover the northernmost exposures of a belt of carbonate strata that extends northwestward through the central part of the New York Mountains. Although close to rail facilities at Ivanpah, the limestone shipped from these claims has been limited to several hundred tons of limestone obtained intermittently. Much of the output was used by the West Coast Kalsomine Company, Los Angeles.

The carbonate belt, part of the Goodsprings dolomite (Cambrian), is in fault contact with an Archean metamorphic complex to the northeast. On the southwest it is bordered by overturned beds of the Bright Angel shale. In outcrop plan the carbonate belt averages about 1000 or more feet wide and is nearly four miles long.

In the Slaughterhouse Spring area the formation contains both dolomite and limestone irregularly distributed. They range from fine- to coarse-grained, are colored from nearly white to medium gray, and are ordinarily massive. The limestone generally shows the lighter shades. A small proportion of silica is locally present, but otherwise the unit appears quite free of non-carbonate impurities. Five small cuts, one of which has yielded virtually all of the limestone output, comprise the workings.

Rattlesnake Gulch Deposit. Location: secs. 27 and 28, T. 2 N., R. 3 E., S.B.M., in Rattlesnake Canyon about 9 airline miles southeast of Baldwin Lake and about 14 airline miles northwest of Yucca Valley. Ownership: W. H. and W. E. Schmidt, Box 611, Yucca Valley, California, own four claims.

The Rattlesnake Gulch deposit was first worked late in 1951. In May 1952 it was yielding each week 40 tons of carbonate rock for use as roofing granules. The deposit is part of the Furnace limestone, a formation extensively exposed in the eastern part of the San Bernardino Mountains. The material is quarried from a white layer of massive, coarsely crystalline rock several hundred feet thick. The layer strikes N. 30° to 40° W., and dips 35° northeast.

The rock is drilled and blasted to a bench, thence trucked half a mile to the mill where it is crushed, screened, and sacked in 100-pound paper bags. Standard size is between $\frac{3}{8}$ inch and 10 mesh, but special sizes are produced from time to time.

Riverside Cement Company Limestone Deposit. Location: secs. 4, 9, 16, 17, T. 6 N., R. 4 W., S.B.M., near Oro Grande; sec. 9, T. 6 N., R. 6 W., S.B.M., at the southwestern end of the Shadow Mountains; and sec. 25, T. 6 N., R. 4 W., S.B.M., east of Victorville. Owner: Riverside Cement Company, 621 South Hope Street, Los Angeles, California.

The Golden State Portland Cement Company, predecessor to Riverside Cement Company at Oro Grande, began making cement in 1910, operating quarries in the vicinity of the old Carbonate gold mine near Oro Grande, and half a mile northeast of the main active Klondike quarry. The Riverside Cement Company acquired the Golden State holdings in 1923. From 1928 to 1942 [174] the properties were idle, but during World War II, the plant was rehabilitated and put into operation. After a brief shutdown at the close of the war, the company began full scale modernization of the plant, and in 1948, completed three 10- by 350-foot dry process kilns. A fourth kiln was scheduled for completion in 1952. During the postwar period limestone has been obtained largely from the Klondike quarry, three-fourths of a mile east of the mill.

The Klondike quarry, about half a mile long, consists of a series of pits and benches driven mainly in blue-gray, medium-grained crystalline limestone, about 200 feet thick. The limestone is overlain by pinkish-white quartzite and is interbedded with it. The general trend of the limestone is northwest, but the deposit is cut by east-trending cross faults that disrupt this trend at both the north and south ends of the quarry. Several granitic intrusions cut the limestone at the west side of the quarry.

Quarries in quartzite and mica schist north and east of the Klondike quarry supply much of the siliceous and aluminous fraction of the cement mix. Surface alluvial and caliche deposits in the vicinity are also used.

The Sparkhule Hill deposit is a very large, undeveloped occurrence of limestone, about three miles northeast of the Oro Grande plant and two miles northeast of the Klondike quarry. Blue-gray, sugary limestone, exposed almost continuously over more than 200 acres, occurs in a gently folded, northwest-trending and northwest-pitching syncline. The limestone is overlapped on the north and west by Pleistocene alluvium and is bordered on the east by the Triassic (?) Sidewinder volcanic series. Low on the southeast side of Sparkhule Hill, sills and dikes of black to dark green andesite intrude the limestone. The limestone is mostly blue-gray, and sugary, but locally ranges from white and coarse-grained to black and fine-grained.

Few data are available on the chemical composition of the limestone in the Sparkhule area. Most of the rock is believed to run much lower than 3 percent MgO, although locally the MgO content exceeds this figure. The Sparkhule Hill deposit is estimated to contain 106 million tons of carbonate rock above the lowest exposure at the north end of the deposit. Over the northern half of the deposit the limestone should extend downward an additional several hundred feet. Still more reserves are indicated beneath Pleistocene alluvium to the west and southwest.

Sheep Creek Deposits. Location: secs. 1, 3, 4, 10, 15, 22, T. 3 N., R. 7 W., S.B.M., 2 miles northeast of Wrightwood. Owner: Lamb Brothers Company owns 1700 acres leased to L. H. Maddux, 14 Apple Street, Wrightwood, California.

[174] Logan, C. A., Limestone in California: California Jour. Mines and Geology, vol. 43, p. 295, 1947.

The Sheep Creek limestone deposits were undeveloped until mid-1950. They have since yielded about 10,000 tons of limestone which has been crushed and sold as roofing granule material.

The principal limestone deposit of the Sheep Creek area is high on the steep west wall of the canyon. The deposit is a lens of limestone that appears to be at least 100 feet thick and 1000 or more feet long. The lens is enclosed by granite, trends northwest and dips steeply.

Similar, but smaller masses are exposed to the southeast and northwest of the main deposit. Numerous granite dikes, largely decomposed, penetrate the limestone and complicate quarrying and processing operations. The limestone, a cloudy-white, translucent and coarsely crystalline rock, is admirably suited to the manufacture of roofing granules. Analyses of numerous composite and spot samples are reported by the operator to show the following ranges: $CaCO_3$ 93.44-97.84 percent; $MgCO_3$, 1.32-3.15 percent; SiO_2, 1.68-2.77 percent; Al_2O_3, 0.38-0.81 percent; Fe_2O_3, 0.10-0.52 percent.

Southwestern Portland Cement Company Deposits. Location: secs. 5, 6, 8, T. 6 N., R. 2 W., west extension of Sidewinder Mountain; secs. 2, 10, 11, 14, 15, 16, T. 6 N., R. 4 W., 3 miles east-northeast of Oro Grande; and sec. 2, T. 6 N., R. 6 W., at east end of Shadow Mountains, S.B.M. Owner: Southwestern Portland Cement Company, 727 West 7th Street, Los Angeles, California.

The plant of the Southwestern Portland Cement Company at Victorville has been in continuous operation since 1916. Until 1942, all raw materials were obtained from quarries just east of Quartzite Mountain, 6 miles north-northeast of Victorville. In 1942 a heavy duty road to the Reserve deposit, 14 miles east of the plant, was opened. During the period 1947-48, a company railroad was extended 5 miles eastward toward the Reserve quarry. From 1948 to 1950 very large limestone deposits were explored and developed at Black Mountain northeast of the Reserve quarry and a new kiln was completed, increasing the plant's annual capacity to 3,000,000 barrels. During 1951 the railroad was extended another 6 miles to the base of Black Mountain and quarrying of limestone at the Quartzite Mountain and Reserve quarries was discontinued.

Twelve quarries were worked in the Quartzite Mountain area. Here limestone is interbedded with quartzite and mica schist. In many places the limestone has been silicated near contacts with intrusive granitic bodies. The limestone, silicated rock, and granite have all been used as portland cement ingredients. The limestone beds pinch and swell markedly and the Oro Grande series has been severely folded and faulted. Parts of a northeast-trending anticlinal structure still remain. The crystalline limestone is medium-grained, blue-gray rock which, where unaltered, averages about 52.0 percent CaO, 2.4 percent MgO, 2.7 percent SiO_2, 1.6 percent Al_2O_3, 0.7 percent Fe_2O_3, and 40.6 percent ignition loss.

In addition to rock obtained from the main quarry area, several million tons of limestone were taken from Quarry No. 12 on the northwest slope of Quartzite Mountain a mile west of the main quarry area. This rock was part of a thrust plate which caps the mountains. Because of

FIGURE 28. Plant of Southwestrn Portland Cement Company, Victorville.

FIGURE 29. Quartzite Mountain limestone quarry of Southwestern Portland Cement Company, northeast of Victorville. Observer faces southeast. Limestone of Oro Grande series exposed on quarry face.

the steepness of the slope and the thick quartzite overburden, further quarrying in this area was discontinued. The limestone averages slightly higher in magnesia and silica than the unaltered limestone from the main quarries.

The Reserve quarry, 5 miles east of Sidewinder Well, is in a northeast-trending ridge underlain by coarsely crystalline, white limestone of the Oro Grande series. The limestone dips steeply northwestward. Quarrying has been hindered by dikes of diorite and quartz diorite porphyry which are too magnesian for use in cement. The unaltered limestone is high-grade and contains less magnesia than limestone in the Quartzite Mountain area. Although the Reserve operation has been suspended, more than half of the easily quarried reserves remains.

The quarries on Black Mountain, which is about 800 feet high, are on the south slopes and about half a mile northeast of the Reserve deposit. The entire mountain is underlain by limestone conglomerate, about 1350 feet thick, and the uppermost member of the Permian (?) Fairview Valley formation.[175] The axis of a tightly folded, symmetrical syncline trends about N. 40° W. and close to the long axis of the mountain. The total limestone thickness is thereby about 2700 feet. In spite of a detrital origin, the composition of the limestone is sufficiently uniform to meet specifications of cement manufacture. Except for a small proportion of brown chert pebbles and cobbles and interstitial silicification, the rock is entirely limestone. An average composition, based on company analyses taken through 1600 feet of diamond drill cores shows 46.0 percent CaO, 3.3 percent MgO, 11.0 percent SiO_2, 1.7 percent Al_2O_3, 0.8 percent Fe_2O_3, 37.2 percent ignition loss. More than 300,000,000 tons of limestone exist above the lowest exposure on the mountain.

Van Dusen Canyon Deposits. Location: sec. 3, T. 2 N., R. 1 E., S.B.M., about 2 miles northwest of Big Bear City and low on the north wall of Van Dusen Canyon. Owners: J. R. Anderson and R. C. Huston, 1426 Guess Street, Rosemead, California.

The Van Dusen Canyon limestone property was opened in 1950, and operated for about one year, yielding several thousand tons of rock. The material, marketed mostly as roofing granules, was crushed, sized and bagged on the property. Late in 1951, however, the milling equipment had been removed.

The quarry is in a bold outcrop of white to pale gray, fine-grained, crystalline, dolomitic limestone in the Furnace formation (Mississippian?) which is extensively exposed in Van Dusen Canyon and on Bertha Peak to the west. The rock is moderately tough and compact. The quarry is at the base of a north-trending ridge. The limestone strikes eastward and dips vertically to steeply northward. A thickness of about 200 feet of limestone is exposed between the quarry floor and a contact between limestone and Saragossa quartzite north of the quarry. The highest limestone exposures on the ridge are about 100 feet above the canyon bottom. The overburden is negligible.

Victorville Lime Rock Company Deposits. Location: secs. 25, 35, T. 6 N., R. 4 W., S.B.M., four airline miles northeast of Victorville. Owner-

[175] Bowen, O. E., Jr., Geology and mineral deposits of the Barstow quadrangle, California: California Div. Mines Bull. 165, in press, 1953.

ship: Properties totaling 120 acres in SW¼ sec. 25 are owned by Riverside Cement Company, 621 South Hope Street, Los Angeles, California, and leased by Victorville Lime Rock Company; properties in sec. 35 are owned by Victorville Lime Rock Company, 5225 Wilshire Boulevard, Los Angeles, California.

For a period of 22 years, beginning in 1924, the Victorville Lime Rock Company quarried crude limestone from property leased from the Riverside Cement Company. In 1943 the quarries now being operated were opened on company property. In 1945 the company became a subsidiary of E. K. Williams and Company, East St. Louis, Missouri.

In the vicinity of the present operation crystalline limestone is discontinuously exposed in a group of low hills, and lying in a belt about one mile long. In this operation high-purity limestone is being removed from a section of limestone and dolomite beds in the Oro Grande series. The attitude of the beds is obscure but the carbonate rocks crop out in an arc convex to the southeast. The limestone is coarse- to medium-grained and blue-gray to white. To date, only the coarse, rhombic-grained white rock has been quarried. Much of this white material is over 99 percent $CaCO_3$ and is used in glass manufacturing. Because of the distribution of granitic intrusions, contact-altered zones, and alluvial cover, estimation of reserves is difficult, but several million tons of high-grade rock lie above the lowest point in the quarry area. Rock is quarried in a series of low benches and hauled by truck to the company mill on the railroad at Victorville. In some places 5 to 15 feet of overburden must be removed.

The dry-grinding mill is equipped with air separating equipment and has a 24-hour daily capacity of 40,000 tons of crushed limestone of various particle sizes. Glass "sand," white filler, chicken grit, roofing granules, stucco and limestone for lime are the principal products marketed.

White Rock Limestone Quarry. Location: sec. 32, T. 3 N., R. 2 E., S.B.M., (projected), about 3½ miles northeast of Big Bear City. Ownership: Walter Jenkins, Joshua Tree, California, owns one claim which is leased to C. W. Lower, Big Bear Lake, California.

The White Rock limestone quarry, opened in 1949 and operated intermittently until mid-1951, has yielded several hundred tons of material for use in the manufacture of roofing granules. The quarry is on the western end of a west-trending ridge underlain by carbonate strata of the Furnace formation (Mississippian?). Here the formation is a white, massive, medium- to coarse-grained, crystalline limestone. The beds strike west-northwest, dip nearly vertically, and are free of overburden. The rock was crushed and screened at a small mill on the property.

Magnesite

Production of magnesite in San Bernardino County has totaled only a few hundred tons. No magnesite has been produced in recent years.

Most of the magnesite in the county occurs in bedded deposits associated with Tertiary sedimentary rocks. The deposits are probably of sedimentary origin. In two deposits, the Ball and the Richter on the north slope of Sidewinder Mountain, magnesite occurs as thin seams and narrow replacement bodies along fractures in Paleozoic (?) dolomite.

FIGURE 30. View north toward Victorville Lime Rock Company quarries northeast of Victorville. Quarries are in limestone of Oro Grande series.

FIGURE 31. Plant of Victorville Lime Rock Company, Victorville.

The Needles magnesite deposit, one of the bedded type, probably contains the largest reserve of mineable magnesite having a low percentage of impurities.

Ball Magnesite Deposit. Location: sec. 2, T. 6 N., R. 2 W., S.B.M., on the northwest spur of the Sidewinder Mountains, and about 14 airline miles northeast of Victorville. Ownership: O. H. Ball, 2024 West 62d Street, Los Angeles, California, owns four claims.

The Ball Magnesite deposit consists of magnesite replacement bodies in dolomite of the Oro Grande series of Carboniferous age. The bodies range from knife-edge veinlets to elongate lenses and irregular veins as much as 2 feet wide. They are distributed through a dolomite thickness of about 200 feet. In general they strike northeast, dip moderately northwest, following fractures in the dolomite. The magnesite appears pure, but of small recoverable tonnage.

The property has been developed by 10 or 12 crosscut adits driven northwesterly into the hillside at different elevations. These range in length from about 10 feet to over 40 feet.

New Trail Magnesite (Cima) Deposit. Location: secs. 15 and 16 (?), T. 15 N., R. 14 E., S.B.M., on the east flank of the Ivanpah Mountains about 7 airline miles southeast of Mountain Pass and about 34 airline miles east of Baker. Owner: New Trail Mining Company, La Calino Ranch, Riverside, California, Mrs. H. I. Kent, president. Lessee: W. H. Hile, 95 Monterey Road, South Pasadena, California.

The New Trail magnesite deposit, on the property of the New Trail copper mine, has a total output of several hundred tons obtained in 1918 and the early 1930's, but has been idle since. The magnesite occurs as two veins, about 75 feet apart, along bedding planes in dolomitic limestone. The veins strike west-northwest and dip about 40° S.

The south vein is only a few inches wide and is exposed for about 100 feet on the surface. The mining has been confined to the north vein, which ranges from 2 to 4 feet in width over an exposed distance of about 150 yards. The magnesite has been conspicuously fractured by fault movement in the plane of the vein, the ore being brecciated and recemented with magnesite. The vein contains abundant earthy, porous magnesite as well as a dense, hard type.

The workings consist of 2 inclined shafts that follow the vein, and are about 250 feet apart. These are appended to drifts and stopes. The workings are reported to be 80 feet in maximum depth, but all workings beneath about 30 feet are now inaccessible.

Kramer Hills Deposit. Location: secs. 3 and 4, T. 9 N., R. 6 W., S.B.M., about 1½ airline miles southwest of the site of the settlement of Kramer Hills. Owner: O. H. Ball, 2024 West 62d Street, Los Angeles, California.

The Kramer Hills deposit is a prospect consisting of thin beds of impure magnesite interbedded with Tertiary shale. Production, if any, was small. The magnesite beds range from a fraction of an inch to a foot in thickness, and commonly are streaked with white opal and chert. They appear to be confined to a shaly unit about 200 feet thick. Development consists of a single trench, 4 feet wide and 5 to 8 feet deep.

Perlite, Pumice, Pumicite, and Volcanic Cinders [176]

Although the production of perlite, pumice, pumicite, and volcanic cinders in San Bernardino County has not been large, these materials do occur in extensive deposits. They are of volcanic origin and range from mid-Tertiary to Recent in age. Pumice, for use as aggregate material, has been mined from deposits north of Barstow since 1947. Perlite production has been limited to a few thousand tons for plaster aggregate and experimental purposes. Volcanic cinders for use as medium- to lightweight aggregate material have been removed from Mt. Pisgah cone east of Newberry and from another cone a few miles west of Bagdad.

Although large perlite deposits exist in the Castle, Bristol, and Turtle Mountains, only those in the Castle Mountains have been worked commercially. The product has been used mainly as light-weight plaster aggregate. Deposits in the Bristol Mountains have been explored, but have yielded only a small tonnage for experimental use.

Perlite deposits of various sizes exist in the Newberry, and Van Winkle Mountains, in the mountains about 18 miles north of Barstow, and near Pilot Knob, 20 miles east of Randsburg.

Castle Mountains Perlite. A perlite-bearing belt, which lies in secs. 28 and 29, T. 15 N., R. 18 E., S.B.M., on both sides of the California-Nevada line in the northern part of the Castle Mountains, has been developed by several quarries. Three operators now control perlite properties on the California side: Lewis Cox, 810½ Main Street, Las Vegas, Nevada; the More-Lite Minerals Corporation, Riverside, California; and the L. S. Whaley Lumber Company, 6544 Cherry Avenue, Long Beach, California. In 1952 a property formerly operated by N. Tomiyasu was acquired by the More-Lite Minerals Corporation. The Nu-Lite Corporation, Box 216, Fontana, California, has holdings on the Nevada side. Late in 1952 only the More-Lite and Nu-Lite quarries were active.

The perlite lies largely or wholly in a single zone exposed low on the north slope of Hart Peak and extending southward for at least three-quarters of a mile along the northeast flank of the peak. Although much of the zone is hidden beneath mantle and talus, individual perlite bodies of commercial interest appear to be 40 to 50 feet in maximum thickness and as much as several hundred feet long. The zone is part of the thick section of Tertiary acidic volcanic rocks that underlies all of the Castle Mountains and contains clay and gold workings to the southwest. In the perlite-bearing area the section strikes northeast and dips gently to moderately northwest. The reserves recoverable by quarrying appear to be large.

A pale gray, compact, pearly rock is said by the operators to be the material of highest grade. Associated with it is a slightly to moderately porous rock also of commercial interest. Locally abundant in the perlite are geodes and veinlets of chalcedony. At the Cedar Top deposit of the Whaley Lumber Company, the perlite contains large spheroidal cavities partly filled with siliceous material.

Perlite from the More-Lite quarry, the most northerly of the group in California, is being trucked via Ivanpah or Searchlight to the com-

[176] Most of the data in this section have been kindly contributed by C. W. Chesterman, California Division of Mines.

FIGURE 32. More-Lite perlite quarry at northern end of Castle Mountains. Bedrock in photo consists mostly of acidic volcanic rocks. Observer faces southeast.

pany's Riverside plant where the material is processed. The Cox property, which adjoins the More-Lite property on the southeast, has been partly developed, but not put into continuing operation. The Tomiyasu quarry, about a quarter of a mile farther south, was idle late in 1952, but appears to have yielded a small tonnage in previous operations. The Cedar Top quarry, lying about a quarter of a mile still farther south, was active during the period 1947-51 when from 100 to 150 tons of perlite were shipped each month to processing plants in the Los Angeles area. The rock was carried from Ivanpah via the Union Pacific Railroad.

Craik Perlite. Location: T. 4 N., R. 21 E., S.B.M., on the east side of the Turtle Mountains about 30 miles southwest of Needles, California. Ownership: A. Craik, 380 North Hill Avenue, Pasadena, California, owns two groups of claims.

The Craik perlite deposits, although large and thoroughly tested, have been mined only for experimental material. The perlite occurs as flows ranging in thickness from a few feet to several tens of feet. The flows of perlite are closely associated with flows of rhyolite and thick beds of tuffs and tuffaceous sediments which dip steeply westward. Dikes of basalt and andesite commonly cut the tuffs, rhyolite flows, and perlite.

Dish Hill Volcanic Cinders. Location: sec. 16, T. 6 N., R. 10 E., S.B.M., on Dish Hill near the Santa Fe railroad at the old siding of Trojan between Siberia and Bagdad. Ownership: The State of California owns section 16 as school land; 160 acres are now leased to the Velvatone Stucco Products Company, 2066 Hyde Park Boulevard, Los Angeles, California.

A small tonnage of volcanic cinders has been mined at Dish Hill for use as aggregate in plaster and stucco. Reserves are very large. Dish Hill is a small basaltic cinder cone, about 500 feet high, and breached on the west side. It rests on granitic rocks and is one of several cones on the southwest side of the Bristol Mountains. The cinder material, which is composed of scoriaceous fragments, is dark red to black in color, and is high in strength.

The cinders are removed by benching on the south slope of the hill. The faces are blasted and the broken rock is fed by bulldozer into the conveying, crushing and screening system. Coarse aggregate is produced in minus 1-inch plus $\frac{3}{8}$-inch and minus $\frac{3}{8}$-inch plus $\frac{1}{16}$-inch sizes. The minus $\frac{1}{16}$-inch material is further screened to a plus and minus 30-mesh fraction for plaster and stucco sand, respectively. Plant capacity is planned for 30 tons of sand per day.

Glassy Rock Perlite. Location: sec. 32, T. 8 N., R. 10 E., S.B.M., on the southwest flank of the Bristol Mountains, about 6 miles northeast of Klondyke, a siding on the Santa Fe railroad. Ownership: George W. Rust, Box 718, Kentfield, California, owns 180 acres in the southeast quarter of the section.

Although the deposits of perlite on the Glassy Rock are large and contain a large tonnage of expansible perlite, their output has totaled only several hundred tons for experimental purposes.

The perlite occurs in irregular to lens-like bodies that range in thickness from a few feet to 50 feet and are at least 1000 feet in maximum

length. The perlite ranges in color from dark to light gray and commonly shows reddish-brown streaks. In places it is brecciated and pumiceous. At the main quarry where a bulk of the perlite has been mined, it is quite massive and shows both granular and splintery fractures. In mid-1952 the property was idle.

Harper Perlite. Location: sec. 22, T. 8 N., R. 13 E., S.B.M., on the northwest flank of Van Winkle Mountain about 18 miles northeast of Amboy. Ownership: Harry F. Heather, 2365 Oak Knoll Avenue, Pasadena, California, owns two claims.

The Harper perlite deposits occur as lens-like flows ranging in thickness from a few feet to several tens of feet. Although most of the lenses are not exposed for their full lengths, several appear to contain very large reserves of expansible perlite. The perlite is medium gray in color and has a splintery fracture. It is associated with flows of rhyolite and tuff beds, forming a section which rests upon a coarse-grained granite. These deposits have not been worked.

Hicks Perlite. Location: secs. 35 and 36, T. 31 S., R. 44 E., M.D.M., in the upper part of Black Canyon about 20 miles northwest of Barstow. Ownership: J. E. Hicks, 5944 Middleton Street, Huntington Park, California, owns one claim.

A small tonnage of expansible perlite has been taken from this property for experimental purposes. The perlite occurs as lens-shaped bodies of various sizes associated with rhyolite and tuffaceous sediments. In general they are similar to the Pilot Knob deposits noted below. The Hicks perlite is light to dark gray in color, highly brecciated, and commonly traversed by numerous veinlets of pink chalcedony and opal.

Mt. Pisgah Volcanic Cinders. Location: sec. 32, T. 8 N., R. 6 E., S.B.M., about 12 airline miles westward from Ludlow and 2 miles southward from Pisgah siding. Ownership: Harry F. Heather, 2365 Oak Knoll Avenue, Pasadena, California (one-half interest), Oscar Hoerner, 5211 Delaware Avenue, Los Angeles, California (one-quarter interest), and Fred A. Wilson, San Bernardino, California (one-quarter interest), own two 160-acre claims.

A small tonnage of cinders has been mined from the Mt. Pisgah cone and used mostly as test material. The Lavalite Corporation, A. R. Haller, operated the property briefly in 1948.

Mt. Pisgah, a volcanic cone about 300 feet high, is composed of basaltic bombs and scoriaceous fragments. This material ranges in color from dark red to black, and is quite strong. The bottom of the crater in the cone is partly covered by flow basalt. Basalt flows also extend out from the base of the cone and form a rough, craggy surface.

The cinders were mined by a scraper operating downslope in a trough on the west side of the cone. A bulldozer was used to push the cinders into the feed bin for a screening plant which is now dismantled. The sized material was stockpiled.

Pilot Knob Perlite. Location: sec. 3, T. 29 S., R. 44 E., M.D.M., about 3 miles north of Pilot Knob and 24 miles northeast of Randsburg. Ownership: Joe Foisie and Chet Williams own two claims which now lie within

FIGURE 33. View of volcanic cinder quarry on west slope of Mt. Pisgah. Flow in foreground is ropy or pahoehoe basalt.

an area which, for use by the Army, has been withdrawn from the public domain.

The Pilot Knob perlite deposits are exposed in a group of low hills composed largely of Tertiary lavas and tuffs which dip gently westward, and rest unconformably upon granite. The perlite occurs as flows as much as 100 feet thick. These are bordered, top and bottom, by rhyolite flows and thick beds of tuff and tuff breccia.

Most of the perlite is massive and brecciated, and shows a well developed ''onion-skin'' structure. Crystals of quartz, sanidine, and biotite are thinly scattered through the rock. Locally the perlite is pumiceous, a feature especially characteristic of the brecciated rock. The deposits remain undeveloped.

Santa Fe Railway Pumicite. Location: sec. 13, T. 5 N., R. 15 E., S.B.M., about 3.5 miles southeast of Siam, a siding on the Santa Fe railroad. Ownership: the Santa Fe Railway owns eight claims.

The Santa Fe pumicite deposit was located in a search for a substitute for fly ash to be used in pressure grouting fractures and cracks in concrete. By mid-1952 no pumicite had been shipped.

The pumicite occurs in an extensively exposed tuff layer which is about 50 feet thick and dips gently westward. It is overlain by several basalt flows.

The tuff layer appears to consist of alternating beds of pumicite, of which some are coarser than others. The best pumicite, however, is in an 8-foot bed which lies at the bottom of the unit. The workings consist of several shallow cuts and pits.

Williams Brothers Pumice. Location: secs. 7, 8, 17, 18, T. 32 S., R. 46 E., M.D.M., about 18 airline miles northeast of Hinkley, and 8 miles northeast of Harper Dry Lake. Ownership: F. M. Williams, Star Route, Barstow (two claims), and Southern Pacific Railroad (80 acres leased to Mr. Williams).

The Williams Brothers quarry, opened in 1947, has yielded several thousand tons of pumicite for use in the manufacture of light-weight building blocks, mortar mix, and plaster.

In the area is exposed a series of Tertiary volcanic rocks, resting upon deeply eroded Mesozoic granite rock. The series strikes northwest and dips moderately northeast. The pumice is largely confined to a 90-foot thickness underlain by tuffaceous beds and overlain by layers of rhyolite and perlite. The pumicite occurs in two layers, the lower about 12 feet thick and the upper nearly 70 feet thick, separated by about 20 feet of tuff breccia. The layers can be traced laterally for a mile or more. Both consist mainly of angular pumice fragments ranging in diameter from a fraction of an inch to several inches in a loosely consolidated matrix of pumicite.

Most of the marketed pumicite has been removed from a single quarry in the thicker layer. Although blasting is occasionally required, the quarry faces ordinarily can be worked with only a bulldozer. Screening in a trommel on the property produces material of two sizes, one ranging from $\frac{1}{2}$ inch to $\frac{3}{32}$ inch in diameter, the other less than $\frac{3}{32}$ inch. The coarser grade is used in the pumice building blocks, the finer grade in mortar and plaster.

Sand and Gravel, Crushed Rock, and Riprap

In each year following World War II, the sand and gravel produced in San Bernardino County has totaled from 1 to $1\frac{3}{8}$ million tons, and has been valued at 1 to $1\frac{1}{2}$ million dollars. These figures, more than three times the averages for the ten-year period preceding the war, reflect the post-war upswing in building and heavy construction.

The sand and gravel operations of San Bernardino County are in the stream channels and alluvial fans that flank the San Gabriel and San Bernardino Ranges. Most of the excavations lie along the washes and tributaries of Lytle Creek and the Santa Ana River which contain debris derived from the southeastern San Gabriel Range and southwestern San Bernardino Range respectively. One operation, near Barstow, lies to the north of the mountains. Most of the deposits are poorly sorted,

crudely stratified, and unconsolidated. Layers and lenses of fine-grained silt commonly interfinger with coarser-grained sand and pebble-to-boulder conglomerate. The sand is arkosic.

A granite quarry at Declezville, south of Fontana is the principal source of riprap for use in the Los Angeles area. This quarry has supplied material for the San Pedro and Long Beach breakwaters. Limestone, dolomite, and volcanic rocks, obtained from various localities are crushed for use as roofing granules.

The rock fragments range from angular to moderately well rounded. In general they consist of the metamorphic and granitic intrusive rocks so extensively exposed in the bedrock of their respective drainage areas. Rock fragments in Lytle Creek wash consist largely of granitic rock and quartzite, less abundantly of volcanic rocks of intermediate composition and granitic gneiss. Mica schist, arkosic sandstone and acidic volcanic rock fragments are present in subordinate proportions. In the Santa Ana wash the most abundant rock fragments are of granitic composition. Quartzite, schist, and volcanic rocks are common but less abundant.

Brubaker-Mann Roofing Granule Plant. Location: sec. 33, T. 10 N., R. 1 W., S.B.M., 2 airline miles northeast of Barstow, half a mile south of Highway 91-466 on the old Soap Mine Road. Ownership: The mill site is owned by Lee Haney, Star Route 1, Barstow, California, and is leased by Ronald Brubaker and William Mann, Star Route 1, Barstow, California.

The Brubaker-Mann Company has been producing moderate quantities of natural colored roofing granules since mid-1950. Rock is quarried at various localities and processed at the mill. Green granules are obtained from a green andesite exposed about 4 miles north of Midway and 40 miles northeast of the mill. Green rock is also quarried from an epidote-rich lime-granite contact rock near Stoddard Well, about 20 miles southwest of the mill.

Red granules are produced from andesite mined near Newberry. Pink and brick-red granules are obtained from volcanic flows and tuffs mined along the Barstow to Camp Irwin road, about 20 miles northeast of the mill. Brown granules are produced from iron-rich siliceous limestone obtained several miles east of the mill.

The rock is sent successively through a primary jaw crusher, a set of rolls, a shaker screen, and a sack loading machine. A standard size granule of ½ inch to 8 mesh is produced, although sizes of as much as 1½ inch are ground as ordered. Mill capacity is 20-30 tons per 8 hour day.

Declezville (Declez) Granite.[177] Location: sec. 35, T. 1 S., R. 6 W., S.B.M., on northwest flank of Jurupa Mountains, and about 1½ miles south of Declez. Owner: Southern Pacific Railroad, Los Angeles address, 610 South Main Street. Lessee: Columbia Construction Company, 8007 South Western Avenue, Los Angeles, California.

Most of the granite mined in San Bernardino County has been removed from the Declezville quarry, which was opened by the present owner prior to 1900. The quarry has been operated mainly for riprap used

[177] MacKevett, E. M., Geology of the Jurupa Mountains: California Div. Mines Special Rept. 5, p. 13, 1951.

by the railroad and in the construction of breakwaters, less extensively for building stone and curbing in the Los Angeles area.[178]

The quarry lies on one of the most northerly of the known exposures of the Bonsall tonalite, a granitic rock extensively exposed in the Peninsular Ranges to the south. In the vicinity of the quarry the tonalite is relatively free of the basic inclusions that are common in it elsewhere. It is overlain by a soil overburden, about 3 feet thick, and contains evenly spaced, northwest-trending joints which facilitate quarrying. The rock is easily removed and reserves are large.

The quarry is worked along a face that trends northward for about 1400 feet, thence eastward for about 700 feet. The face is about 100 feet in maximum height. For several years in the early 1900's it yielded riprap for use in the San Pedro breakwater. More recent operations supplied riprap for the Long Beach breakwater. The quarry has been inactive since early in 1950.

Fontana Pit. Location: sec. 12, T. 1 S., R. 6 W., S.B.M., on Lime Avenue, immediately south of Arrow Street, Fontana. Owner: Fontana Gravel Company, P. O. Box 157, Fontana, California.

The pit of the Fontana Gravel Company is an excavation in the alluvial fan that spreads from the mouth of Lytle Creek Canyon about 6 miles to the north. The deposit consists of lenses of material ranging from fine-grained sandstone to fanglomerate containing boulders 2 feet or more in diameter. The larger boulders are not common and are discarded when encountered.

The pit, irregular in plan, is 500 feet long, 200 feet wide, and from 20 to 40 feet deep. A power shovel mines the material, which is trucked to a nearby crushing, screening and washing plant where it is fed through a grizzly and a 1⅝-inch scalping screen; the oversize is sent through a gyratory crusher. The equipment also includes a finishing screen and washer. Plant capacity is about 125 tons per hour.

Washed material is used as concrete aggregate. Unwashed material, mostly minus ¼-inch, is used in the production of the pre-mixed asphalt surfacing.

Operations began in 1946 and a steady output has been maintained. Fifteen men are employed.

George Herz Pit. Location: sec. 31, T. 1 N., R. 4 W., S.B.M. (projected), at crossing of Lytle Creek wash with Base Line Avenue. Owner: Lytle Creek Land and Water Improvement Company, Rialto, California. Lessee: Mr. George Herz and Company, Base Line and Lytle Creek, San Bernardino, California.

The pit and plant of George Herz and Company are used entirely in the production of unwashed aggregate material for asphalt paving. The pit, which is in the alluvium of Lytle Creek wash, was about 900 feet long, 450 feet wide and 25 feet in maximum depth in mid-1952. The material is mined by power shovel and trucked to the plant which is nearby. Boulders more than 14 inches in diameter are discarded.

After passing through an 8-inch grizzly, the material is fed to a trommel, equipped with a 2-inch screen, in closed circuit with a primary jaw crusher and two secondary cone crushers; trommel undersize and the crushed product are mixed with 3 to 4 percent of silt. This mixture is

[178] Cloudman, H. C., Huguenin, Emile, Merrill, F. J. H., and Tucker, W. B., San Bernardino County: California Min. Bur. Rept. 15, pp. 896-897, 1919.

then separated into 4 size grades by means of vibrating screens. Plant capacity is about 110 tons per hour. Twenty men are employed.

Holliday Pit. Location: sec. 26, T. 1 S., R. 5 W., S.B.M. (projected), on Santa Ana Avenue in Colton, about one-fourth mile east of Riverside Avenue. Owner: Holliday Rock Products Company, P. O. Box 496, Colton, California.

The sand and gravel pit of the Holliday Rock Products Company is on a branch of Lytle Creek wash. The alluvium, which is typical of the Lytle Creek drainage, consists of lenses and layers of sand, gravel and fanglomerate with boulders as much as 9 inches in diameter. Operations have been confined to the uppermost 40-foot thickness, the pit bottoming on a clay-rich layer about 5 feet thick but underlain by coarser material.

The pit, which in mid-1952 was about 40 feet in maximum depth, 550 feet long, and 350 feet wide, is mined by power shovel. The material is trucked to a nearby plant which includes a primary jaw crusher, a secondary cone crusher, a wet screen and a dry screen. Plant capacity is about 200 tons per hour. A wide variety of products, both washed and unwashed, is produced. The washed material is used largely in ready-mixed concrete. The unwashed material is used as aggregate for asphalt surfacing. Fifteen men are employed.

Johnson Brothers Pit. Pit location: sec. 8, T. 1 S., R. 4 W., S.B.M. (projected), in Lytle Creek wash, on south side of U. S. Highway 66. Plant location: 1945 West 4th Street, San Bernardino, California. Owner: H. Norman Johnson, Sr., P. O. Box 469, San Bernardino, California.

The source of material for the crushing, screening and washing plant of the Johnson Brothers Company is a pit in the alluvium of Lytle Creek wash and about 9 miles south of the mouth of Lytle Canyon in the eastern San Gabriel Mountains. Here the channel contains material ranging in

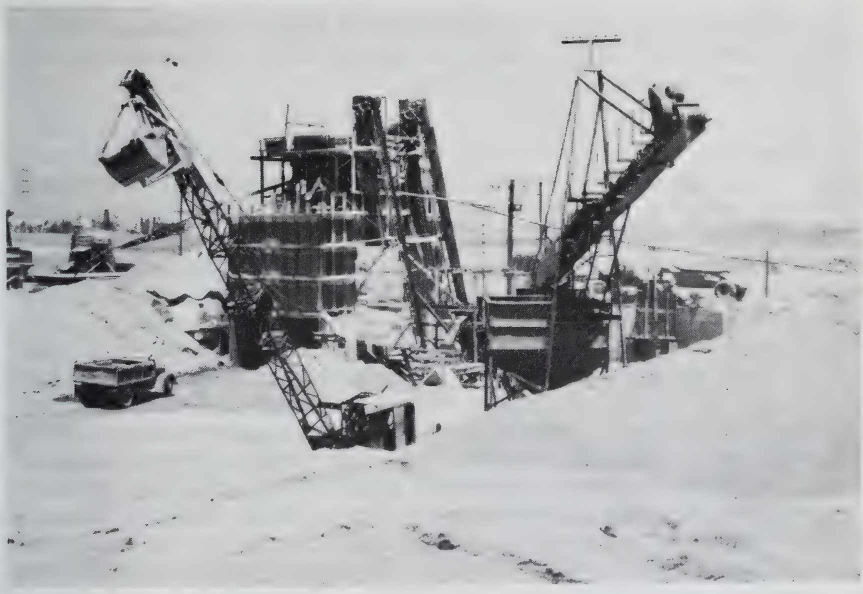

FIGURE 34. Johnson Brothers' sand and gravel pit and plant on Lytle Creek wash.

size from fine-grained sand to boulders as much as 2 feet in diameter. Sand layers predominate; the boulders are relatively uncommon.

The pit, which in mid-1952 was about 700 feet long, 400 feet wide, and 25 feet deep, is mined by power shovel. The material is trucked about one-quarter mile to the plant which includes a primary jaw crusher, a secondary gyratory crusher and screening and washing equipment. Produced at the plant are various products ranging from plaster sand to rock crushed to minus $1\frac{1}{2}$ inch. The plant, which has a capacity of 75 tons per hour, processed 135,364 tons of sand, gravel and crushed rock in 1950. The output is used principally in the preparation of ready-mixed concrete.

The Johnson Brothers Rock and Gravel Company has operated on the site described above for the past fifteen years. For twenty-five years prior to that, operations were carried on north of Highway 66. Forty men are employed.

Mojave Pit. Location: sec. 15, T. 9 N., R. 1 E., S.B.M., 4 miles east of Barstow on U.S. 66. Ownership: Mojave Rock Materials Company, Box 434, Barstow, California owns 3 placer claims.

The Mojave Rock Materials Company operates a sand, gravel, and crushed rock quarry and produces ready-mixed concrete. The quarry was first operated in December 1949.

The quarry is in an alluvial fan which flanks the north slope of the Newberry-Ord Mountains. The material removed is a pebble-to-boulder fanglomerate. Most of the rock fragments are volcanic and acidic to intermediate in composition. Granite and granitic gneiss fragments are subordinate. The material is unconsolidated and poorly sorted.

The deposit is being worked in an open pit which in April 1951 was about 80 feet by 60 feet in plan and 30 feet in maximum depth. The plant includes a 9- by 36-inch crusher and a 4- by 12-foot double-deck screen and washer. Concrete sand is washed; crushed rock and pea gravel are unwashed. Four sizes of crushed rock are produced. Plant capacity is 100 tons per hour. The product is marketed in the area north and east of San Bernardino Mountains.

Redlands Pit. Location: sec. 14, T. 1 S., R. 3 W., S.B.M., in Santa Ana River was, on E. Mill Street, about one-half mile east of Orange Drive, Redlands. Owner: Paul L. Snyder, 267 S. Thomas St., Pomona, and Marshall R. Miller, 533 Brookside Avenue, Redlands, California.

The pit being excavated by the Redlands Gravel Company is in stream channel fill typical of the Santa Ana River wash. Within the deposit are boulders as much as 3 feet in diameter. The larger of these are discarded.

In mid-1952, the pit was about 500 feet long, 400 feet wide, and 30 feet in maximum depth. The material is removed by power shovel and trucked to a plant on the property. The plant includes primary and secondary jaw crushers, a one-inch revolving screen, a gyratory crusher to handle the oversize, and washing and screening equipment for final treatment. The plant has a capacity of about 350 tons per 8-hour shift.

Mr. H. Webster started producing sand and gravel from this location in 1928. Its output was small until 1942 when production was increased by installing heavier equipment. A concrete batch plant operating on the premises services eight transit-mix trucks. Twelve men are employed.

Service Pit. Location: sec. 35, T. 1 S., R. 5 W., S.B.M. (projected), at Riverside Drive and Agua Mansa Road, Colton, California. Owner: Service Rock Company, 2313 Hall Avenue, Riverside, California.

The pit of the Service Rock Company is on what may be an old branch of the Lytle Creek wash about one-half mile northwest of the Santa Ana wash. Here alluvium contains boulders from 6 to 8 inches in diameter and a high precentage of pea gravel. As much as 4 feet of alluvial silt covers the deposit. The pit is about one-quarter mile long, 200 feet wide and from 14 to 18 feet deep. The material is excavated by power shovel and trucked to the plant.

At the plant, the material is successively fed through a primary jaw crusher, secondary cone crusher and screening and washing equipment. The plant has a maximum total capacity of 300 tons per hour. Several commercial grades of wash aggregate, ranging from plaster and concrete sand to 1½-inch crushed rock, are produced. Unwashed sand is sold to plants preparing pre-mixed surfacing asphalt. The crushing and screening plant supplies aggregate to three ready-mix batch concrete plants owned by the company.

Production for 1951 totaled 342,000 tons of all grades. Much of the aggregate and ready-mixed concrete is currently being sent to construction projects at the March Field Air Base. Eighty men are employed.

Tom Woolsey Roofing Granule Plant. Location: sec. 1, T. 9 N., R. 1 E., S.B.M., in Yermo, California, on property owned by Frank Hayes. Ownership: The mill is owned and managed by Tom Woolsey, Box 171, South Pasadena, California.

The Tom Woolsey plant has been producing roofing granules since early in 1951 at the rate of about 25 tons a week. Naturally colored rock is quarried in various places within 50 miles of Yermo and hauled to the mill to be ground. Red granules are produced from red andesite mined near Newberry, green granules from tactite mined near Midway, and pink and brown granules from volcanic rocks obtained near Barstow.

The mill consists of jaw crusher, rolls, single deck shaker screen, and sacker bin and has a capacity of 25 tons per day. The material is marketed in hundred pound sacks of $\frac{7}{16}$, 1, and 2-inch granules.

Triangle Pit. Location: sec. 30, T. 1 N., R. 4 W., S.B.M. (projected), at 2400 West Highland Avenue, in western part of the city of San Bernardino. Owner: Lytle Creek Land and Improvement Company, Rialto, California. Lessee: Triangle Rock and Gravel Company, P. O. Box 2098, San Bernardino, California.

The pit of the Triangle Rock and Gravel Company is in the alluvium of Lytle Creek wash where the wash crosses Highland Avenue about 6 miles downstream from the mouth of Lytle Creek Canyon. The material consists of stream channel fill ranging from fine grained sand to boulders 15 inches or more in diameter.

Sand, gravel and rock are mined with a power shovel and trucked to the plant on the property. The plant contains a primary jaw crusher, a secondary gyratory crusher and washing and screening units. After sizing, washing and drying, the several grades are stored separately in the open. For use in ready-mixed concrete, the aggregate is trucked to a plant about two miles east of the pits. The operation yields several size grades ranging from plaster sand to 2½-inch rock. Three-inch rock

is produced upon demand. Three hundred tons per hour is the average plant capacity. Between 200,000 and 250,000 tons of sand, gravel and crushed rock were produced in 1951.

The company has produced rock and gravel since 1922 from three previous locations in the area and the currently leased property. Production is obtained from six pits. Sixty men are employed.

Tri-City Pit. Location: sec. 9, T. 1 S., R. 3 W., S.B.M., on Palm Drive about one-fourth mile south of Third Street, Redlands, California. Owner: City of Redlands; lessee D. L. Holliday, Tri-City Rock Company, Box 672, Redlands, California.

The pit of the Tri-City Rock Company is in typical alluvium of the Santa Ana River wash, which ranges from fine-grained sand to boulders as much as 3 feet in diameter.

The pit, when visited early in 1952, was about 800 feet long, 300 feet wide, and as much as 25 feet deep. The material is removed by power shovel, and trucked to a plant on the property where it is fed through a primary jaw crusher, secondary cone crushers, and screening and washing units. Some of the material is marketed unwashed for use as aggregate in asphalt surfacing. The remainder is used in concrete.

The plant began operating early in 1950. It has a capacity of 125 tons per hour, and processed about 200,000 tons of material in 1951. Twenty men are employed.

Silica

A moderate quantity of silica (quartz) has been steadily produced in San Bernardino County in recent years, chiefly for use in refractories and in sulfate-resistant cement. The principal sources are quartzite beds and lenses in the Paleozoic metamorphic series near Oro Grande and Barstow. Felsite from the Ivanpah deposit in the Castle Mountains also is marketed as a silica rock.

Atlas Silica Quarry. Location: sec. 17, T. 6 N., R. 4 W., S.B.M., at the southwest end of Silver Mountain about one mile northeast of Oro Grande. Ownership: Mineral Materials Company, Alhambra, California, owns five claims and operates the property.

The Atlas quarry has been in operation since 1939, and is currently one of the major sources of silica and quartzite in southern California. From 12 to 15 men are employed in the quarry operations which yield several tens of thousands of tons each year.

A large body of quartzite of the late Paleozoic Oro Grande series is being quarried. The active face was 50 feet high and several hundred feet long in 1951. Extensive reserves are indicated.

Quarrying is by open pit methods, using wagon drills, bulldozers, power shovel, and 10-ton pit trucks for the 2½ mile haul to the rail spur. A crushing and screening plant is also in operation. The bulk of the output is used in sulfate-resistant cements, but a large tonnage, crushed and screened to minus 2 inches, is used in refractories.

Ivanpah Silica Quarry. Location: sec. 19 or 30, T. 14 N., R. 18 E., S.B.M. (projected), one-fourth mile southeast of the P. S. Hart clay quarry and about 13 miles east-southeast of Ivanpah. Owner: Pomona Tile Manufacturing Company, 629 North La Brea Avenue, Los Angeles, California. One claim.

The Ivanpah quarry yields a material marketed under the trade name "silica," but which actually is a hard, very fine-grained felsite locally altered to clay. The felsite occurs in an extensive layer, at least 20 feet thick, which forms part of the series of Tertiary acidic volcanic rocks well exposed in the Castle Mountains to the north.

Since the deposit was opened in the mid-thirties, several thousand tons of rock have been removed. The quarry, which lies on the northwest flank of a low hill, is now about 150 feet long, 100 feet wide, and a maximum of 20 feet deep. The rock is trucked to Ivanpah and hauled by rail to the lessee's Los Angeles mill where it is ground and bagged for use as a paint extender and as a filler.

Talc

Talc mining in San Bernardino County is confined to two areas, each containing a distinctive type of deposit. The larger talc-bearing area lies athwart the San Bernardino-Inyo County line, extends from the southeastern slope of the Panamint Range eastward to the Kingston Range, and includes the southern part of Death Valley. The smaller area is a belt about 12 miles long extending from the hills northeast of Silver Lake eastward to the Yucca Grove area.

Within the southern Death Valley-Kingston Range region are about 40 localities containing known talc deposits of commercial interest. Most of these are in San Bernardino County. In 1950, deposits of this region, including several in Inyo County, yielded more than 70,000 tons of talc. The Western deposit, which was opened in 1910, has been worked the most extensively and for the longest continuous period. In recent years, however, the Superior, Monarch (shut down in 1950), and Ibex mines have been worked on scales comparable with that of the Western. In recent years too, significant talc yields have been obtained at the Acme, Excelsior, Harry Adams, Pongo, Pleasanton, Saratoga, Tecopa (Smith), and White Cap mines. The Amargosa, Annex, Berryhill, Booth, Ceramic and Rogers mines have been idle. The A. C., Anderson, Blue White, Brown, Crystal Spring, Kingston No. 1, Kingston No. 8, Patricia, Sheep Creek, and Van Talc deposits remained prospects early in 1952.

The Silver Lake-Yucca Grove area contains the Silver Lake mine about 7 miles northeast of the Silver Lake playa, the Pomona and Calmasil mines near Yucca Grove, and several prospects. Of these, the Silver Lake mine, first worked in 1916, is the oldest and largest operation. The other two mines have been operated continuously since the early forties. The combined output of the three totaled between 15,000 and 20,000 tons for 1950.

Deposits of the Southern Death Valley-Kingston Range Region

The talc deposits of the southern Death Valley-Kingston Range region are confined to the Crystal Spring formation of Algonkian age. This formation, which is more than 4000 feet in maximum thickness, contains a lower 1000 to 2000 feet of conglomerate, quartzite, and shale successively overlain by a massive carbonate member (dolomite and limestone) several hundred feet in thickness, and an additional several hundred feet of alternating quartzite, shale, and dolomite layers. Diabase sills, ranging in thickness from a few feet to more than 1000 feet, intrude

these sediments. The general features of the formation have been described by Hewett [179] and Noble.[180]

The talc deposits are alterations of the carbonate member. Those of commercial interest exist at or near the base of the carbonate member and are spatially related to a persistent diabase sill. Intrusive contacts between the sill and carbonate rocks everywhere show a degree of alteration; but talc bodies that can be mined economically are much less extensive. A few exceed 1000 feet in length; most are less than 500 feet long. Where mined, the thickness of commercial talc generally lies within the range of 8 to 30 feet.

The commercial talcs consist of several varieties distinguished principally by their proportions of contained talc and tremolite and by their textures which, from place to place, are thinly laminated, schistose, or blocky. Most of them contain serpentine and carbonate material in proportions of several percent each. The talc ranges in color from white to very pale shades of gray, green, or pink. All varieties are very fine-grained. The alteration zones also commonly contain rocks rich in such minerals as potash and soda feldspars, sericite, and silica; but these rocks are of no present commercial interest.

Deposits of the Silver Lake-Yucca Grove Region

The talc deposits of the Silver Lake-Yucca Grove region occur in a series of highly metamorphosed sedimentary rocks of probable Archean age.[181] The deposits are lenticular, generally from 4 to 15 feet wide, as much as 800 feet long. They have formed by an almost complete silication of certain carbonate strata, probably originally dolomite. Most of the bodies contain both massive tremolite rock and talc schist. Much of the tremolite rock contains abundant serpentine veinlets. In general these alteration rocks are coarser grained and poorer in carbonate material than the commercial talcs of the southern Death Valley-Kingston Range region. The deposits characteristically occur within a quartz-diopside-feldspar hornfels member. The metasedimentary series also contains abundant muscovite schist, biotite schist, quartzite, and marble. Throughout the belt the series has been extensively invaded by igneous bodies ranging in composition from basic to acidic and most commonly composed of quartz diorite. These rocks ordinarily show a pronounced planar structure; most are probably also Archean in age.

A. C. Deposits. Location: sec. 31, T. 20 N., R. 7 E., S.B.M. (projected), about 5 airline miles southwest of Tecopa. Ownership: Sam Malinak, Tecopa, California, and L. B. Kingsley, 450 Por La Mar Drive, Santa Barbara, California, own six claims.

The A. C. deposits are a group of relatively small and little-developed talcose lenses lying along a north-trending belt about one mile long. Bedrock in the area is largely hidden beneath a cover of Quaternary fanglomerate, but at several places the talc-bearing zone of the Crystal Spring formation is exposed. As it does elsewhere in the southern Death Valley-Kingston Range, the zone occurs at a contact between diabase and carbonate strata.

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179 Hewett, D. F., The geology and mineral resources of the Ivanpah quadrangle: U. S. Geol. Survey Prof. Paper, in press.

180 Noble, L. F., Structural features of the Virgin Spring area, Death Valley, California: Geol. Soc. America Bull., vol. 52, pp. 941-999, 1941.

181 Miller, W. J., Crystalline rocks of southern California: Geol. Soc. America Bull., vol. 57, pp. 457-540, 1946.

On the A. C. claims the talc bodies have various attitudes and are ordinarily thoroughly brecciated. Most of the talc of possible commercial interest occurs in layers less than 6 feet thick. None of these appears to extend laterally for more than 150 feet. The talc is a blocky to schistose material, and is locally tremolitic. By mid-1952 none had been marketed. The workings consist of several cuts, short adits, and shallow shafts.

Acme Mine. Location: secs. 9, T. 19 N., R. 8 E., S.B.M. (projected), in central part of Alexander Hills, about 8½ airline miles southeast of Tecopa and 1½ miles south-southeast of Western mine. Owner: Southern California Minerals Company, 320 South Mission Road, Los Angeles, California.

The Acme mine, a name formerly applied to the nearby Western mine, was first operated during the period 1939-43, was reopened briefly in 1948, and was again put into continuous operation in 1951. By mid-1952 the total output was estimated at about 5,000 tons.

The commercial talc, almost entirely a well-laminated, very hard, tremolitic variety, occurs apparently as a southward extension of the main Western deposit. For a distance of about one-half mile between the two deposits, however, surface exposures are hidden beneath alluvium.

At the Acme mine the talc-bearing zone occurs in two adjacent blocks, one striking eastward, the other striking north-northeastward. These dip moderately to the south and east. The more northerly block contains the talc body of greatest commercial interest. Where exposed, this body is persistently about 8 feet thick. By early 1952 it had been followed underground for a horizontal distance of 280 feet, and down-dip from the surface for more than 100 feet. It is probably much more extensive than these minimum dimensions.

The talc, like that at the Western mine, lies above the lowest of the large diabase sills in the Crystal Spring formation and is an alteration of dolomite. Its hardness and uniform thickness permit mining operations with virtually no timbering.

A tunnel, totaling about 800 feet in length, and a 100-foot inclined shaft comprise the workings. The level workings include a drift on the southerly block, a 280-foot crosscut through diabase, and the main 280-foot drift on the talc body noted above. The operators plan to join the shaft and the main drift.

Harry Adams Mine. Location: sec. 10, T. 20 N., R. 10 E., S.B.M. (projected), low on the north slope of Kingston Peak and about 19 airline miles east of Tecopa. Owner: Harry Adams, 1406 Waterman, San Bernardino, California.

The Harry Adams mine has developed part of a talcose zone that lies within the Crystal Spring formation and extends from the Beck Spring area eastward for about 1½ miles to the vicinity of Kingston Pass. Except for several relatively small and widely spaced exposures of talc-bearing bedrock, the zone is hidden beneath Quaternary talus and alluvium. The principal mine workings lie about one-fourth mile west of Beck Spring.

The zone which appears to strike west-northwest and to dip nearly vertically, is bordered on the north by diabase. The talc is probably an alteration of dolomite, but none of the unaltered rock was observed by

the writer. In the vicinity of the mine workings the alteration zone is at least 75 feet in width. Talc schist of proved or probable commercial value comprises at least half of the width. In its average development farther east, the zone is probably much thinner.

Most of the talc has been removed from drifts joined to a 50-foot vertical shaft. When the property was visited early in 1952, the shaft had caved below the 35-foot level and the drifts were inaccessible. East of Beck Spring are several shallow cuts and short adits in which talc schist is exposed but which do not fully traverse the zone.

Amargosa (Acme) Mine. Location: sec. 34, T. 20 N., R. 7 E., sec. 3, T. 19 N., R. 7 E., S.B.M. (projected), on the west bank of the Amargosa River, 1½ airline miles south-southwest of China Ranch and 4½ miles south-southeast of Tecopa. Owner: undetermined.

Largely because of its proximity to the Tonopah and Tidewater Railroad, now abandoned, the Amargosa mine was among the first talc operations in San Bernardino County. It was most actively worked in the period 1915-20; its total output probably did not exceed 10,000 tons.

In the mine area, rocks of the Crystal Spring formation occur in a complex terrane described by Noble [182] as consisting of numerous small, highly brecciated fault blocks lying above a major thrust fault. The principal talc body is about 350 feet in maximum observed length, trends north-northeast, and dips moderately to gently eastward. It lies along a post-fault plane separating blocks of dolomite, diabase and jasper. The body pinches and swells from a few inches to as much as 10 feet in thickness, and is composed mostly of soft talc schist, commonly stained with iron oxides and interfingering with sub-commercial alteration rock. A similar, though smaller, zone lies several hundred feet to the northwest.

The main zone has been mined by stopes connecting three adits which enter the hillside at vertical intervals of about 30 feet. The workings consist mostly of drifts and total about 800 feet in length. These follow the talc to points where it pinches out.

Annex (Mammoth) Mine.[183] Location: sec. 35, T. 17 N., R. 8 E., S.B.M. (projected), on west slope of the Silurian Hills, and about 18 miles north of Baker. Owners: George Peterson and A. E. Barton.

The Annex talc mine has a total output of not more than 1000 tons which was obtained largely or entirely in the period 1940-42. The mine is at the west end of a talcose body that strikes west-northwest, dips steeply northward, and can be traced laterally for about 1500 feet. The body lies along the upper margin of the lower diabase sill in the Crystal Spring formation, and has altered from dolomite at the base of the carbonate member. The same alteration zone, though offset by several cross-faults, is exposed for about 1000 feet west of the Annex body and, in a broad arc, for several thousand feet to the south and southwest. For most of its length the zone is composed of rock of little or no commercial interest.

The commercial talc ordinarily lies next to the diabase. In the vicinity of the Annex workings the talc body ranges from 2 feet to 15 feet in thickness, contains abundant inclusions of wall-rock, and is highly sheared.

[182] Noble, L. F., op. cit., pp. 991-992.
[183] Much of the information in this description was obtained in informal communication with Donald H. Kupfer.

The principal mine workings consist of a 120-foot drift-adit and appended, irregular stopes. To the east of the adit the zone is exposed for a distance of 30 feet in an open cut. Here it contains only a 2-foot width of talc of commercial interest.

Berryhill Mine.[184] Location: sec. 35, T. 17 N., R. 8 E., S.B.M. (projected), about one-fourth mile south of Annex talc mine on west slope of Silurian Hills, and about 18 airline miles north of Baker. Owner: undetermined.

The talc body at the Berryhill mine is on a southward extension of the alteration zone that contains the Annex mine described above. In the Berryhill mine area the talcose zone is traceable laterally for about 800 feet along the upper margin of the diabase sill. The zone strikes north-northeastward and dips moderately to gently eastward. For most of its length, the zone contains little talc of commercial interest. The bodies of commercial talc are six feet or less thick, are highly sheared and cut by granitic dikes.

An estimated 2,000 tons of talc has been obtained from this mine, which probably has been idle since the early 1920's. The mine workings are in two areas about 250 feet apart. The higher and more southerly of the workings consist of a 40-foot crosscut and a 40-foot drift from which a stope extends to the surface. The other workings, composed of short, connected adits, inclined winzes and stopes, have followed a talc body for about 150 feet alongstrike and 50 feet downdip.

Booth Mine. Location: sec. 12, T. 19 N., R. 8 E., S.B.M. (projected), at the eastern tip of the Alexander Hills about 11 miles east-southeast of Tecopa. Ownership: Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California, owns two claims.

Operations at the Booth mine were mostly in the period 1921-1935, when about 15,000 tons of talc were removed by the present owner. The talc lies along a fault contact between Archean granitic gneiss and an overlying massive dolomite of the Crystal Spring formation. The thickness of 1000 or more feet of quartzite, shale, and diabase normally forming the lower part of the formation, has been cut out by the fault which Noble[185] has tentatively identified as the Amargosa thrust of late Tertiary age. Upon casual observation the talc appears to have been localized by the fault. Actually, however, the pre-Cambrian diabase sill that ordinarily is in contact with the region's other talc deposits and is genetically related to them, has been faulted out, and the talc has formed a weak zone along which the major slippage occurred.

The zone and the dolomite above it strike westward and dip gently northward. At the surface the zone can be traced laterally for about 1,100 feet. The talc ranges from a few inches to as much as 20 feet in thickness. Some is blocky, but most is schistose and crumbly.

The mine workings consist principally of two adits; the lower driven westerly from the eastern end of the knob; the other, about 50 feet higher, opens on the south side of the knob. Each follows the talc zone for a distance of about 1,000 feet.

[184] The data in this description were obtained largely in informal communication with Donald H. Kupfer.
[185] Noble, L. F., Structural features of the Virgin Spring area, Death Valley, Calif.: Geol. Soc. America Bull., vol. 52, p. 994, 1941.

Calmasil Mine. Location: sec. 3, T. 15 N., R. 11 E., S.B.M., about one mile north of Yucca Grove, and 19 airline miles northeast of Baker. Ownership: Southern California Minerals Company, 320 South Mission Road, Los Angeles, California, owns three patented claims.

The Calmasil mine, opened by the present owner in 1940, had yielded about 16,000 tons of commercial talc through 1951. The deposit consists of a lens, 6 feet in average width, which underground workings have followed laterally for a maximum of 200 feet and down-dip for more than 250 feet. The deposit is enclosed by a limestone unit which is part of a complex of metasedimentary and granitic rocks similar to the Archean (?) talc-bearing terrane at the Silver Lake mine described below.

The deposit is in a talcose belt several thousand feet long which includes the Pomona deposit to the northwest. The Calmasil deposit strikes N. 50° W. and dips steeply northeast. The talc is a blocky to schistose, fine-grained, white material. Locally it contains a high proportion of tremolite. The deposit lenses laterally into sub-commercial talcose rock.

The workings consist of two principal levels. One is reached by a 200-foot southwest-trending crosscut adit, encountering the southeastern end of the deposit, and appended to a 150-foot drift most of which has been removed by stoping. The second level is a 200-foot drift joined to the first by a 90-foot winze steeply inclined to the northwest. The unusual firmness of the walls has permitted mining with very little timber and a recovery of more than 90 percent of the commercial material.

Ceramic Mine.[186] Location: sec. 4, T. 16 N., R. 9 E., S.B.M. (projected), on the west slope of Silurian Peak and about 17 airline miles north of Baker. Owner: undetermined.

The Ceramic mine has yielded an estimated 500 to 1000 tons of talc obtained largely or wholly during the period 1940-42. The mine has developed a relatively small talc body in a zone of silicated rock about 2000 feet in exposed length. The deposit is an alteration of limestone and lies above the lowest of the large diabase sills in the Crystal Spring formation. Here the alteration zone strikes northwest and dips moderately to the northeast. In the mine area all units of the formation are cut by abundant cross-faults and bedding plane faults. The talc is blocky to well laminated and generally unstained.

The main mine workings lie along a 250-foot segment of the zone where the commercial talc is confined to a 2- to 5-foot thickness adjacent to the diabase. The southern workings consist of two levels separated by a vertical distance of about 25 feet. Talc has been stoped between an upper 75-foot drift and a lower 125-foot drift. The northern workings contain a 75-foot drift appended to a small stope.

Crystal Spring Deposits. Location: sec. 30, T. 20 N., R. 10 E., S.B.M. (projected), at Crystal Spring in western part of the Kingston Range. Owner: John Prato, 2134 West Valley, Fontana, California.

The Crystal Spring talc deposits, partly explored but never actively worked, are a series of talcose lenses which have formed at about the same stratigraphic position near the base of a massive, siliceous dolomite member of the Crystal Spring formation. Though poorly exposed on a

[186] Most of the data in this description were supplied by Donald H. Kupfer in personal communication.

southerly slope, they appear to be distributed along a belt at least 1500 feet long. The diabase sill, ordinarily in contact with the talc deposits of the region, lies a few tens of feet stratigraphically beneath the Crystal Spring deposits. The deposits and the nearby Crystal Spring units strike eastward and dip moderately to steeply northward.

The talc exposed in a 160-foot east-trending adit, driven on the most westerly talcose exposures, averages less than 3 feet and does not exceed 6 feet in thickness. A 40-foot vertical shaft, about 200 feet east of the adit portal, has been sunk on a talcose lens about 25 feet in maximum width and probably not more than 200 feet long. The talc ranges from friable and schistose to compact and blocky.

Excelsior Deposit. Location: secs. 30 and 31, T. 20 N., R. 11 E., S.B.M. (projected), on the east slope of the Kingston Range, and about 25 airline miles north-northwest of Valley Wells. Ownership: Southern California Minerals Company, 320 South Mission Road, Los Angeles, owns 12 claims and one millsite.

The Excelsior talc-bearing zone, which lies above the lower diabase sill of the Crystal Spring formation, is exposed for a lateral distance of about 7000 feet, strikes northward, and dips gently to moderately eastward. Virtually all of the 31,000 tons of talc mined from the deposit through 1951 has been obtained from the southern end of the zone. The mine was opened in 1936 by the present owner.

The alteration zone ranges in thickness from a few feet to more than 200 feet, but commonly contains a high proportion of rock of no commercial value. At several places, however, are talc bodies ranging from 200 feet to more than 1000 feet long and from 6 to 20 feet thick. Fine-grained tremolite rock and soft talc schist are both abundant. The former is characteristically next to the diabase. The latter is commonly separated from the diabase by subcommercial alteration rock.

The principal workings consist of two adits which extend northward from a hill-slope at the southern end of the zone; the entrance of one is about 110 feet higher and 200 feet farther north than the entrance of the other. Both are essentially drifts with appended stopes and follow a zone of talc schist along or near the diabase contact. The lower adit is 780 feet long, the higher one is about 1000 feet long. Less extensive workings below the lower adit are joined to it by means of a 90-foot winze. Late in 1951 operations were switched to another adit about 2000 feet north of the lower entrance. This adit, intended to encounter a body of talc schist within the alteration zone, had been driven about 300 feet by January 1952.

The talc is hauled by truck via Valley Wells to Dunn siding on the Union Pacific Railroad and thence to grinding mills in Los Angeles, and in Ogden, Utah.

Halloran Spring (Calmasil Extension, Great Wanamingo) Deposit. Location: sec. 31, T. 16 N., R. 11 E., S.B.M., 1¾ miles northwest of Paso Alto and about 17 miles northeast of Baker. Owner: A. J. Rygh, 1409 Calumet Avenue, Los Angeles, California.

The Halloran Spring talc deposit, though similar in character and geologic setting to the deposits of the Silver Lake mine area about 11 miles to the west, has not been actively worked. The deposit consists of lenses of white, massive tremolite rock bordered by green hornfels, and

occurring in a layered section containing abundant quartzite, biotite schist, granitic gneiss, basic dike rock and pegmatite. The lenses and the bordering metasedimentary rocks strike west-northwest and dip moderately southward.

The tremolite rock is exposed laterally and continuously for a distance of about 250 feet, and appears to consist principally of two lenses with maximum widths of about 8 and 15 feet, separated by about 15 feet of green hornfels. They have been explored by three shafts, ranging from 15 to 50 feet deep, and by an open cut.

Ibex (Moorhouse) Mine. Location: sec. 35, T. 20 N., R. 5 E., S.B.M. (projected), near southern end of Ibex Hills, and about 12 airline miles west-southwest of Tecopa. Owner: C. O. Gould Estate, Frank Clapp, executor, 1107 South Broadway, Los Angeles, California. Leased to Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

Since the Ibex mine was placed in production in 1940, it has been in nearly continuous operation and has yielded about 50,000 tons of commercial talc. The talc deposits of the mine area occur in seemingly disordered blocks within a major fault zone that strikes northwestward across the southern part of the Ibex Hills. The blocks are composed of dolomite, limestone, diabase and silicated rocks of the Crystal Spring formation. Some of the talc occurs along diabase-dolomite contacts, but most is enclosed by slightly to thoroughly silicated sedimentary carbonate rocks. Although numerous talc bodies exist in the mine area, nearly all of the talc mined to date has been obtained from a single zone as much as 80 feet wide and 700 feet long. The zone is very irregular in detail and discontinuous in plan. Inclusions of waste are abundant and numerous talcose shoots extend from the main body into the walls. The part most actively mined strikes from north-northeast to northwest and, in general, dips moderately eastward. Its northern exposures are about 150 feet higher than its southerly ones.

This part of the zone has been penetrated by three north-trending drift adits whose portals are within 200 feet of its most southerly exposures and are spaced at vertical intervals of about 60 feet. From the lowest to the highest, these adits are 600 feet, 550 feet, and 290 feet long respectively. They are irregular in detail and joined by relatively large stopes in which square-set timbering has been commonly employed.

Kingston No. 1 Deposit. Location: sec. 5, T. 19 N., R. 11 E., S.B.M. (projected), about one-fourth miles southeast of the principal Excelsior mine workings, and about 23 airline miles northeast of Valley Wells. Ownership: Frank Funk, Valley Wells, California, owns three claims. All are leased to Al W. Smith, Box 41, Tecopa, California.

The Kingston Number One talc deposit consists of the southeastern tip of the zone that, to the northwest, contains the Excelsior deposits noted above. The deposit is discontinuously exposed for a lateral distance of about 500 feet, trends northwestward and dips gently to steeply northeastward. The talc is friable and well foliated. The zone is from 8 to 20 feet thick for most of its length, but contains abundant inclusions of green, limy alteration rock. To the northwest it appears to lens into subcommercial alteration rock; to the southeast it terminates against a major fault. The workings consist of several cuts and several

shafts each less than 20 feet deep. To date no talc has been shipped from the property.

Monarch Mine. Location: sec. 35, T. 20 N., R. 5 E., S.B.M. (projected), low on the east face of the Ibex Hills, and about 16 airline miles south-southwest of Shoshone. Owners: Ralph Morris and associates, Room 804, 612 South Flower Street, Los Angeles, California. Formerly leased to Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

About 50,000 tons of commercial talc have been obtained from the Monarch mine in operations which began in 1943 and ended in October 1950. The mine was worked by the present owners until 1945 when it was leased by the Sierra Talc and Clay Company. The deposit, an alteration of dolomite, lies at the upper margin of the lower diabase sill in the Crystal Spring formation. The sill and the lower sedimentary units of the formation strike northward, dip steeply eastward, and are prominently exposed along the east face of the Ibex Hills.

The deposit is an irregular pod about 80 feet in maximum thickness and probably not more than 420 feet in maximum dimension. It is composed principally of schistose rock rich in the mineral talc, but containing local, highly tremolitic masses. The body contains a low proportion of subcommercial waste rock.

The mine workings have explored the deposit for a slope-distance of about 250 feet and laterally for a maximum of about 290 feet. They consist of adits at three principal levels about 60 feet vertically apart. The deposit was found to be about 260 feet long in the highest adit, 290 feet long in the middle adit and 170 feet long in the lowest adit. The talc has been mined, from the lowest adit to the surface, by means of large stopes in which much square-set timbering was employed. The former lessees estimate that, above the lowest adit, about 70 percent of the marketable talc has been removed.

Pleasanton Mine. Location: sec. 35, T. 20 N., R. 5 E., S.B.M. (projected), 300 yards south of the Monarch talc mine, low on the steep, southeastern flank of the Ibex Hills, and about 16 airline miles south-southwest of Shoshone. Owner: undetermined.

The Pleasanton talc mine was opened in early 1942 and leased in October 1942 to the Muroc Clay Company. In 1946 the lease was acquired by the Sierra Talc and Clay Company. The mine has yielded an estimated 5,000 to 10,000 tons of talc, but has been idle since 1947.

In plan the deposit is crescent-shaped, convex to the southwest, 600 feet long, and 60 feet in maximum width. It dips steeply southwestward. The talc, a schistose, generally friable material, is an alteration of dolomite of the Crystal Spring formation. The deposit is overlain by unaltered dolomite, underlain by diabase of the lower sill, and lenses laterally into dolomite. The deposit appears to shorten with depth and may not extend more than a few tens of feet below the lowest workings.

The talc has been mined by means of a drift adit extending 300 feet northwestward from a point near the southeastern end of the deposit, and by means of another, lower and paralleling adit, driven northwestward about 150 feet from the bottom of a 30-foot shaft inclined 60° northwestward. The shaft collar is about 50 feet southeast of the portal of the adit. Both levels, for most of their lengths, consist of two parallel

drifts, one at the foot-wall, another at the hanging wall. These are appended to overhand stopes.

Pongo Mine. Location: sec. 15, T. 19 N., R. 5 E., S.B.M. (projected), about 3 miles north of Saratoga Spring, and about 32 airline miles northwest of Silver Lake. Ownership: Harvey B. Brown, 824 Lomita Road, San Bernardino, California, owns one claim which is leased to Southern California Minerals Company, 320 South Mission Road, Los Angeles, California.

The Pongo mine, from which talc was first shipped in 1948, has yielded a total of about 8,000 tons in its first four years of operation. Because bed rock in the mine area is largely hidden beneath Quaternary alluvium and dune material, the full extent of the deposit remains undetermined. The talcose zone, developed at a diabase-dolomite contact, is discontinuously exposed for a lateral distance of about 600 feet. It strikes N. 20° E. and dips eastward, at moderate angles, beneath the diabase.

The body of commercial material explored in the underground workings ranges from 6 to 13 feet thick for most of its known extent. Its down-dip dimension is greater than 220 feet. It has been followed laterally for distances of 100 to 140 feet to points where it lenses into slightly altered dolomite. The talc is a thinly laminated to blocky rock composed mostly of the mineral talc, but locally rich in tremolite.

The principal mine workings consist of a 220-foot shaft, inclined S. 77° E. at angles of 28° to 48°, with levels at slope distances of about 60, 120 and 220 feet. These levels extend north-northeastward for distances of 55, 75, and 10 feet and south-southwestward for distances of 85, 65, and 90 feet respectively. In stoping between the levels, from 60 to 70 percent of the commercial rock has been removed. As the walls are firm, the stopes have required virtually no timbering.

Rogers Mine. Location: sec. 33, T. 20 N., R. 9 E., S.B.M., and sec. 4, T. 19 N., R. 9 E., S.B.M. (projected), on west slope of Kingston Range, and 13 airline miles east-southeast of Tecopa. Ownership: F. B. Ortman, 2901 Los Feliz Boulevard, Los Angeles, California, owns 6 patented claims.

The Rogers talc mine was developed mostly in the period 1940-42, when an output of several hundred tons was obtained. The mine has been idle since.

The talc occurs in a zone discontinuously exposed in a belt about 4000 feet long. The zone is an alteration of dolomite of the Crystal Spring formation. Some of the talc bodies lie within the dolomite, but within a few tens of feet above a diabase sill. Others are in contact with the sill.

The zone strikes north to northwest and dips moderately east to northeast. Its exposed length has been divided into two nearly equal segments by a west-trending fault causing the southeastward part to be moved relatively eastward for about 1000 feet.

The zone is poorly exposed in most places but appears to be composed predominantly of subcommercial material. Most of the talc of commercial interest appears to be in bodies less than 10 feet wide and 100 feet long. The more southeasterly part of the zone is intensively invaded by rhyolite.

The principal workings consist of a northeast-trending tunnel, 200 to 300 feet long, joined to the bottom of an inclined shaft about 60 feet

deep. The talc has been removed from overhand stopes at the end of the tunnel. Numerous cuts comprise the other workings.

Saratoga Mine. Location: secs. 26 and 35, T. 19 N., R. 5 E., S.B.M. (projected), about one-half mile north of Saratoga Spring at the southern end of Death Valley. Ownership: H. C. Brown, 824 Lomita Road, San Bernardino, California, owns six claims.

The workings now known as the Saratoga mine were opened in 1950 and were continuously operated in 1951. Older workings (Saratoga No. 1) on the same group of claims lie about one-half mile to the north, but are now idle.

The claims lie athwart a septum of partly to thoroughly altered dolomite in the lower diabase sill of the Crystal Spring formation. The septum strikes north-northeast and dips moderately eastward. It pinches and swells along its strike, ranging from a few feet to as much as 150 feet thick, and is traceable for about 5000 feet. Talcose rock is abundant in the septum, but to date only the body now being worked has proved exploitable. The mine workings consist of a 100-foot shaft inclined at an average angle of about 40°, and with appended southwest drifts extending 100 feet from the 50-foot level and 40 feet from the 100-foot level.

The talc ranges from 5 feet to 20 feet thick, and is generally massive and quite hard. Surface exposures of the zone extend beneath alluvium within 20 feet northeast of the shaft and appear to lens into subcommercial alteration rock about 100 feet to the southwest.

Sheep Creek Deposits. Location: sec. 5, T. 17 N., R. 6 E., S.B.M. (projected), along the northern base of the Avawatz Range, and about 20 airline miles northwest of Baker. Owner: Avawatz Salt and Gypsum Company, 415 Pacific Mutual Building, Los Angeles, California. Four patented claims are leased to Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

In the Sheep Creek area an elongate, talc-bearing block of the Crystal Spring formation, about one thousand feet wide and several thousand feet long, lies within the Garlock fault zone low on the north slope of the Avawatz Range. Although the talcose alteration zone locally has been explored by underground workings, no commercial talc had been shipped by early 1952.

The talc occurs in an alteration zone bordered on the north by the quartzite and shaly units of the lower part of the formation, and on the south by a diabase sill. The zone averages about 60 feet wide and is continuously exposed for a lateral distance of about 2000 feet. The rock of greatest commercial interest is much less extensive and appears to occur largely within 15 feet of the diabase contact. It ranges from a hard tremolite rock to friable talc schist. The alteration zone and the other Crystal Spring units trend west-northwestward and dip steeply to moderately northward. All have been intimately fractured. The zone extends beneath alluvium at its western end and appears to be faulted off east of Sheep Creek.

The most extensive workings, a 160-foot, east-trending, drift adit with appended overhand stopes, are at the west end of the deposit, and were driven in the period 1948 and 1949, when the deposit was under lease to the Western Atlas Company. A 150-foot drift adit trending northwestward from Sheep Creek Canyon, several other shorter adits and numerous cuts are older workings. Work on another adit north-

westward from the canyon was begun soon after the present lessee acquired the property late in 1951.

Silver Lake (Gould, Pacific Coast, Riggs and Best, Tremolite) Mine. Location: secs. 21, 22 and 23, T. 16 N., R. 9 E., S.B.M., (projected) about 10 miles north-northeast of Baker. Owners: M. E. Stearns estate, Los Angeles, California (16 claims) and Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California (4 claims and a mill site). The Stearns' claims are leased to this company.

Several groups of workings are known collectively as the Silver Lake talc mine. These have been driven in lenses of commercial talc lying along a narrow belt about 2 miles long. The talc deposits are part of a series of Archean (?) metasediments composed mostly of quartzite, muscovite schist, biotite schist, hornfels, and crystalline limestone and dolomite, extensively invaded by irregular bodies of rocks ranging from basic to acidic in composition.

For most of the length of the talc-bearing zone, the talc bodies and the enclosing metasediments dip moderately to steeply southward. At its eastern end, broad, open folds are characteristic.

The talc bodies have replaced carbonate rock, an alteration confined largely to strata near the center of a single, predominantly hornfelsic member. The bodies range from a few inches to 40 feet in thickness and are as much as 800 feet long. Commonly two bodies, each 8 or more feet thick, parallel each other.

The bodies contain several rock types of which the principal ones are a tremolite rock, a talc schist and a tremolite-forsterite-serpentine rock. Early in the mine's development, only the talc schist was sought. Now each body is mined from wall to wall; the commercial material, as shipped, is a mixture of various rock types.

The mine, worked almost continuously since 1915, has yielded more than 160,000 tons of commercial talc. This has been obtained from four workings which, from west to east, are known as the Addenda, Gould, Number Two and One-Half, Number Two, and Number Four. Since 1949 most of the output has been obtained from the Addenda and Gould workings. Remaining to be mined are the Addenda Extension deposit at the western end of the zone and the Number Five deposit about one mile north of the main zone.

The Addenda Extension workings consist of a 60-foot vertical shaft at the bottom of which a 30-foot south-trending cross-cut intersects two talc bodies, each about 8 feet thick. The more northerly body has been followed by a drift extending 70 feet westward and 30 feet eastward. The Addenda deposits have been developed by a 65-foot shaft inclined about 57° S. Several talc bodies, mostly from 5 to 15 feet wide, have been encountered in drifts that extend about 300 feet eastward and 60 feet westward from the bottom of the shaft. The Gould workings, by far the most extensive, follow the talc zone down dip to a maximum of about 265 feet. The principal drift is about 1,100 feet long. Here the talc zone is at least 800 feet long and terminates against granitic rock in the deepest workings. The Number Two and One-Half workings consist of a 200-foot shaft, inclined about 60° S., with levels at 60, 120, and 200 feet. These have developed a lenticular talc body about 200 feet in diameter.

FIGURE 35. View west toward No. 2 workings at Silver Lake talc mine. Stopes mainly in layers of talc-tremolite rocks (white) ; bordered by diopside-feldspar hornfels (darker).

The Number Two and One-Half workings consist of an inclined shaft, 150 feet deep, with levels at 50, and 150 feet. Here a talc lens about 200 feet long and 10 feet in maximum width has been largely removed.

At the Number Two workings a talc-bearing zone, about 400 feet long, and containing bodes as much as 30 feet wide, has been mined by a series of shallow drifts and stopes, none more than 60 feet beneath the surface.

The Number Four workings include a 160-foot vertical shaft with three levels and several hundred feet of drifts. The level workings are now largely caved forming a pit, about 200 feet long, from which an additional several thousand tons of talc has been removed. The body was flat to gently dipping and is said by the operators to have been as much as 40 feet thick.

Superior Mine. Location: secs. 25 and 26, T. 19 N., R. 5 E. (projected), S.B.M., 2½ miles north-northeast of Saratoga Spring at the southern end of Death Valley. Ownership: Southern California Minerals Company, 320 South Mission Road, Los Angeles, California, owns three claims.

FIGURE 36. View southwest toward Superior talc deposit. Talc zone underlain on right by dolomite and quartzite of Crystal Spring (Algonkian) formation, overlain on left by diabase sill.

The Superior mine was first operated in 1940 and had yielded about 80,000 tons of commercial talc through 1951. The deposit differs from most others in the region in that the dolomite from which it was altered lies beneath, instead of above, the lowest diabase sill in the Crystal Spring formation.

The talc has been obtained from a body with surface exposures about 750 feet long and 75 feet in maximum width. The body strikes northeast and dips from 60° to 25° southeast. A three-ply structure, consisting of two layers of soft talcose rock separated by a layer of massive tremolitic rock about 40 feet thick, characterizes the northeastern part of the body for 400 feet along the surface. To the southwest and in the lower two levels of the mine, the deposit consists of a single talcose layer. The commercial material mined to date has been obtained from the talcose layers which range from a few inches to as much as 30 feet in width. Most of the tremolitic rock appears sub-commercial.

The mine workings, insofar as possible, have been driven in the talcose layers. At first, talc was removed from an adit, now known as the 65-foot level, with a portal near the deposit's southwestern end. The workings have been deepened by inclined shafts and winzes and include 6 levels separated by vertical distances of 35 to 60 feet. The deepest is about 315 feet lower than the collar of the main shaft which is near the northeastern end of the deposit. At intervals of about 40 feet, the levels are joined by raises which have been enlarged into stopes. Bcause the body was believed to terminate near the shaft and to plunge moderately southward at this, its northeastern end, each level followed the talc layers for successively shorter distances; the 1st (65-foot) level for 750 feet and the 4th level for 440 feet. Late in 1952 the 1st and 6th levels were being driven northeastward, both encountering an extension of the talc body.

Tecopa (Smith) Mine. Location: sec. 35, T. 20 N., R. 9 E., S.B.M. (projected), low on northwestern slope of Kingston Range, about 2½ airline miles south-southwest of Crystal Spring and about 14 airline miles south-southeast of Tecopa. Owner: Sierra Talc and Clay Company, 5509 Randolph Street, Los Angeles, California.

Since 1935, when the Tecopa mine was placed in production, it has yielded an estimated total of about 40,000 tons of commercial talc. The Sierra Talc and Clay Company has been the only operator.

The deposits and the mine workings lie along a narrow, west-trending belt about 1600 feet long. The talc bodies are typical of others in the region in that they are alterations of strata in the lower part of the massive carbonate member (here cherty dolomite) of the Crystal Spring formation. Unlike most, however, the bodies lie several tens of feet above the upper margin of the lower diabase sill. They are overlain by dolomite, but the rocks separating them from the sill consist chiefly of subcommercial alteration rocks and impure quartzite. In several places the talc and the bordering rock is extensively invaded by Tertiary (?) rhyolite. In general, the talc bodies and the other Crystal Spring units strike westward and dip moderately northward.

Most of the talc mined to date occurs in a single zone occupying a persistent stratigraphic position. East of a north-draining wash that divides the mine area, talc also has been removed from another zone about 20 feet stratigraphically above the main one. The bodies pinch and swell,

FIGURE 37. View north toward No. 5 deposit and workings at Western talc mine, Alexander Hills. Deposit is in Crystal Spring (Algonkian) formation. Talc zone continuous between cut in foreground and shaft at left; lies between dolomite on hill to right and diabase sill exposed in left center.

ranging from veinlets a fraction of an inch thick to kidneys and elongate pods 25 or more feet thick. Some of the talc is friable and schistose, but within the larger bodies it is characteristically massive. Both types appear to be tremolite-free. At each end the talc-bearing belt terminates against intrusive rhyolite; extensions of the belt may exist beneath an alluvial cover to the east.

In recent years, mining has been confined to workings east of the wash. These consist mainly of two tunnels along the talc zones. The higher tunnel follows the zone eastward for about 400 feet. About 450 feet north-northwest of its portal and 70 feet lower in elevation, is the portal of the other. This lower tunnel follows the talc-bearing zone eastward for about 800 feet. The talc has been removed from drift faces and from stopes of which the larger ones have required square-set timbering. West of the wash is a 600-foot, west-trending adit joined to an inclined shaft.

Western (Acme) Mine. Location: secs. 32 and 33, T. 20 N., R. 8 E., and secs. 4 and 5, T. 19 N., R. 8 E., S.B.M. (projected), in the northwest part of the Alexander Hills, about 7 miles southeast of Tecopa. Ownership: Western Talc Company, 1901 East Slauson Avenue, Los Angeles, California, owns seven patented and four unpatented claims.

The Western mine, in about 40 years of almost continuous operation beginning in the period 1910-15, has yielded a total of slightly more than 200,000 tons of commercial talc. Its workings, the most extensive of the talc mines in San Bernardino County lie chiefly in an alteration zone adjacent to the upper margin of the lower diabase sill of the Crystal Spring formation. The zone has altered from cherty dolomite at the base of the carbonate member in the middle of the formation.

In the mine area the zone is exposed in several fault blocks, two of which contain by far the most extensive talc bodies. These bodies have contributed virtually all of the mine's output. In the larger of the two occurrences the zone is about 5000 feet in exposed length and from 20 to 100 feet wide. Here the zone trends northward and has an over-all, moderate dip to the east. For most of its length it is exposed low along the west face of the north-trending ridge. Of comparable width is the other large talc-bearing body, about one mile to the northwest, and probably from 1000 to 1500 feet long. But it is in an area of lower relief and is not as well exposed as the occurrence noted above. It also strikes northward and dips moderately eastward. At both localities the zone contains commercial talc through most of its length and width.

The alteration rock of commercial interest ranges in composition from predominantly talc to predominantly tremolite, and in texture from massive to thinly laminated and schistose. A thinly laminated, high-tremolite rock ordinarily lies next to the diabase, forming a foot-wall layer as much as 15 feet thick. Higher in the zone the commercial rock consists of talc schist and a blocky rock rich in tremolite and serpentine. Interfingering with these two types and commonly separating them from unaltered cherty dolomite are lenses and layers of noncommercial alteration rocks.

The 5000-foot segment of the zone was first worked by several adits driven in its northern half. It was later penetrated by inclined shafts spaced at average intervals of about 1200 feet, and designated, from north to south, with the numbers 4, 1, 2, and 3. In the early period talc was also removed from shallow workings on the other large talc body.

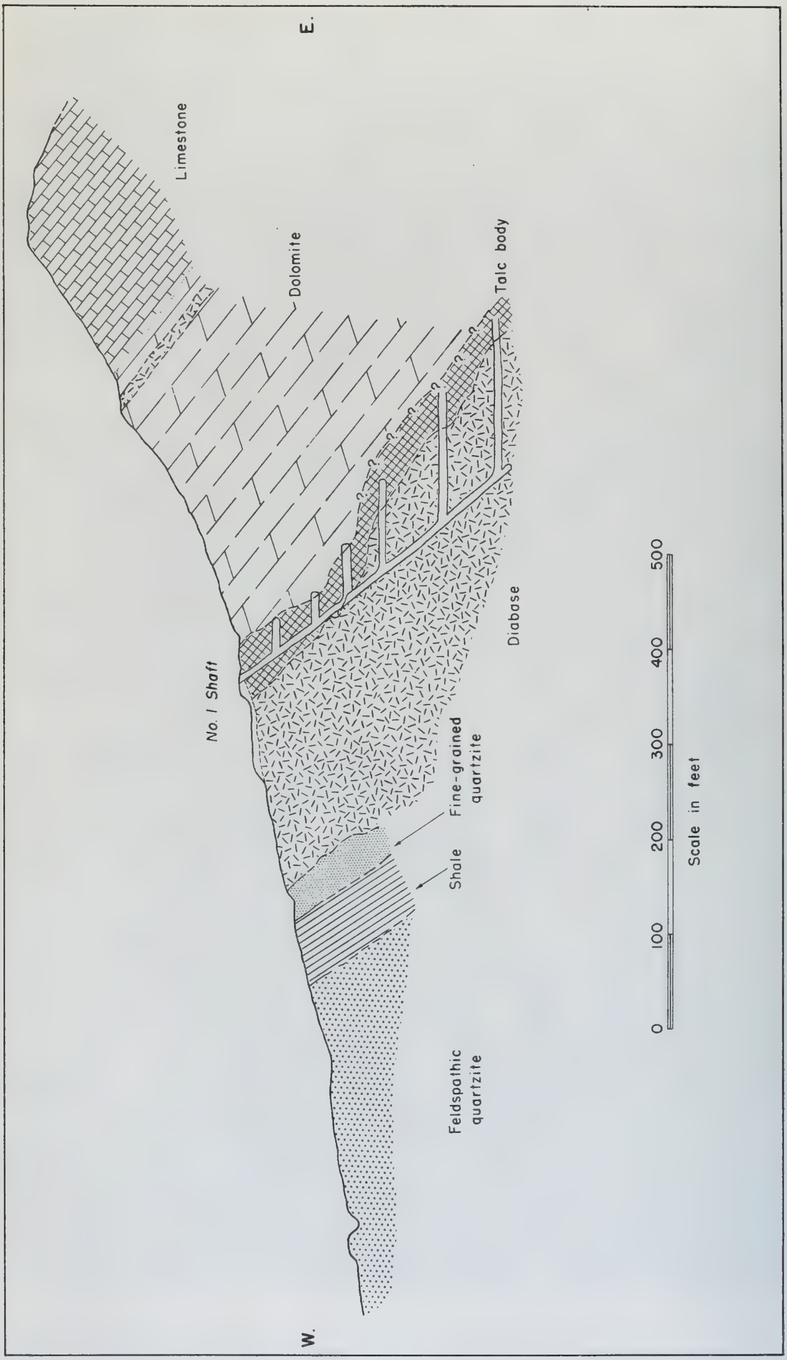

FIGURE 38. Cross-section through Western talc deposit, showing the No. 1 shaft and appended cross-cuts.

The most recently opened workings lie near most northerly surface exposures of the same body. Here the No. 5 shaft was begun late in 1950.

Each of the five shafts was begun on the talc zone and sunk at angles of 55° to 70° eastward. From No. 1 to No. 5 they are 350, 120, 175, 130 and 110 feet deep respectively. Levels have been driven at slope distances of 50 to 100 feet, and are joined to the shafts ordinarily by means of cross-cuts in diabase to the foot-wall of the zone. The talc has been mined mostly from drift faces and irregularly spaced raises. Only a small proportion of the marketable rock has been removed from the developed parts of the main alteration body; but much of the rock that lies within 200 feet of the surface is caved and unrecoverable.

FIGURE 39. Grinding mill of Western Talc Company, Dunn Siding on Union Pacific Railroad.

White Cap Mine. Location: sec. 26, T. 19 N., R. 5 E., S.B.M. (projected), adjoining the Superior Talc mine and about 2 miles north-northeast of Saratoga Spring at the southern end of Death Valley. Ownership: Southern California Minerals Company, 320 South Mission Road, Los Angeles, California, owns three claims.

The White Cap deposit is in contact with the same diabase sill that borders the Superior deposit which lies about 3000 feet to the northeast. The White Cap workings, however, are much smaller. They have yielded about 5000 tons of talc in intermittent operations beginning in 1947.

A continuous belt of alteration rocks in the mine area is at least 1000 feet long, and as much as 50 feet wide, and lies largely beneath the sill. The deposit of proved commercial material, forming but a small part of the belt, is a lens about 400 feet in outcrop length, about 20 feet in maximum width, and is largely in a finger of alteration rock that extends into the footwall of the sill. The lens strikes northeastward and dips southeastward at angles of 30° to 50°. The footwall of the deposit is mostly in contact with diabase; the hanging wall ordinarily is separated

from diabase by sub-commercial alteration rock. The commercial material is highly talcose and ranges from very friable schist to a blocky, crudely laminated rock.

The mine workings lie within the talcose lens and consist of a shaft, inclined southeastward at an average angle of about 40°, with appended levels at slope distances of 50, 100, 140, 160 and 200 feet. The talc has been removed by overhand stopes driven from the 100-foot and 200-foot levels. The 200-foot level, the longest of the five, is about 360 feet long and extends for nearly equal distances on both sides of the shaft. The operators anticipate a deepening of the shaft and the removal of talc from still lower levels.

Yucca Deposit. Location: sec. 21, T. 16 N., R. 10 E., S.B.M. (projected), about 5 miles north-northwest of Halloran Spring. Owner: undetermined.

The Yucca talc deposit is a small lens of massive tremolitic rock similar in appearance and occurrence to the deposits of the Silver Lake mine about 5 miles to the west. The lens strikes N. 50° W. and dips 40° NE., and probably does not exceed 30 feet in maximum dimension. The surrounding terrane is composed principally of granitic rocks and basic dike rocks with subordinate hornfels and quartzite of probably Archean age. The deposit has been explored by a 40-foot inclined shaft bottoming in country rock.

Yucca Grove (Desert Talc and Clay, Pomona) Mine. Location: sec. 4, T. 15 N., R. 11 E., S.B.M., about 1½ miles northwest of Paso Alto, a settlement on U.S. Highway 91 and 466. Owner: Pomona Tile Manufacturing Company, 629 North La Brea Avenue, Los Angeles, California.

Since the opening of the Yucca Grove talc mine in 1938, it has been a captive property whose total output has been used entirely as a wall-tile ingredient and consumed chiefly by the Pomona Tile Manufacturing Company. The mine has an estimated total yield of 50,000 tons of commercial talc.

In its general features the deposit resembles the Silver Lake deposits, about 12 miles to the west. It is part of a terrane of Archean (?) metasedimentary rocks that has been invaded by granitic bodies. The commercial talc, mostly a hard, blocky, and tremolitic material occurs in two parallel layers, each about 8 feet in average thickness, and from 15 to 20 feet apart. The operators have named these the "hanging wall vein" and the "foot-wall vein." Lenses of talc schist from a few inches to as much as two feet thick commonly border the tremolitic layers, and are best developed along the foot-walls. The wall rocks consist variously of impure limestone, micaceous schist, and quartzite. These and the talc deposits strike northwest to west-northwest 50° to 70° to the southwest.

A 228-foot shaft, inclined at about 60° southwest, follows the hanging wall vein and joins two haulage levels, one at 128 feet, and another at 228 feet. These levels consist mostly of parallel drifts, one along each vein. They extend southeastward for 75 and 150 feet respectively. Each extends northwestward for about 550 feet. The talc is removed by overhand stopes appended to the main levels and to several sub-levels. Because the wall rocks are unusually firm, very little timbering has been required.

Salines

The treatment of lake brines and mining of saline deposits, for many years prominent industries of San Bernardino County, in 1951 yielded materials valued at about $12,000,000 or about one-third of the county's mineral output for the year. These operations to date have removed only a small fraction of the saline mineral wealth of the county. The outstanding source is Searles Lake, a playa in the extreme northwest corner of the county. Within 125 feet of the playa surface of Searles Lake are at least two very extensive porous, crystal bodies rich in various salts of sodium, potassium and boron. Brines pumped from the interstices of the crystal bodies are treated at two plants. One plant operated by the American Potash and Chemical Company, produces sodium sulfate, soda ash, potassium chloride, potassium sulfate, borax, boric acid, lithium salt, bromine, and bromine salts; the other, operated by the West End Chemical Company, produces soda ash and borax.

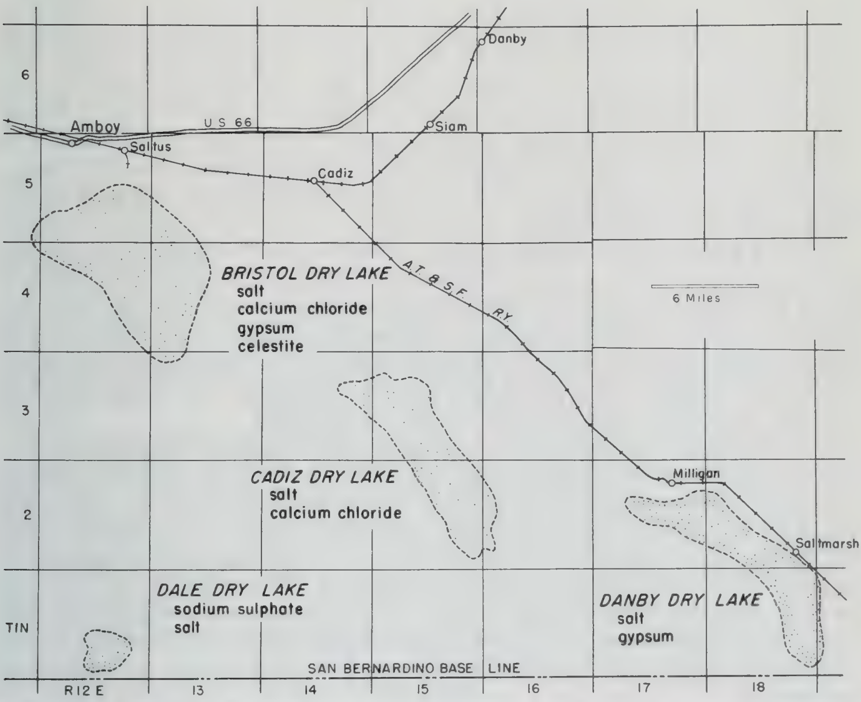

Figure 40. Map of a part of southeastern San Bernardino County showing location of principal saline-bearing dry lakes.

Crystal bodies in Bristol Lake, a playa south of Amboy, are mined for salt by the California Salt Company. Liquid calcium chloride is recovered from the brine of the lake by the California Salt Company and the National Chloride Company; flake calcium chloride is produced from the liquid by Hill Brothers Chemical Company. Deposits along the west margin of Bristol Lake have been the only gypsum sources in the county that have been seriously mined, but have been idle since 1924. Salt was

formerly obtained from the brine of Dale Lake and from near-surface deposits at Danby Lake. Until 1948 sodium sulfate was also obtained from the Dale Lake brine.

Although Searles Lake is now the only commercial source of borax in San Bernardino County, in the past boron-bearing minerals were mined from the playa surfaces of Searles Lake and from bedded Tertiary deposits in the Calico district.

The production of strontium-bearing minerals was confined to the periods of World Wars I and II when celestite was obtained from deposits in the Cady Mountains and strontianite from deposits north of Barstow. In the mid-1920's magnesium salts, in crusts and mixed with clay in shallow deposits, were mined at a locality near Wingate Pass. This operation was unsuccessful.

Searles Lake. Searles Lake playa, whose surface covers more than 40 square miles in the northwestern corner of San Bernardino County, is the remnant of a much larger lake. In the more moist climate of Pleistocene time, integrated drainage is believed to have extended from Owens Lake, southward and eastward through lakes in Indian Wells Valley and Salt Wells Valley, to Searles Lake which in turn emptied northward into Panamint Valley and thence perhaps into Death Valley.[187] Indian Wells Valley and Salt Wells Valley, which contain thick, detrital deposits, are thought to have served as settling basins for Searles Lake. Probably supplementing the dissolved salts derived from rock-weathering was much soluble salt of volcanic origin.

During a long period of dessication, extending to the present, the water of Searles Lake became a saturated brine from which were precipitated huge, porous crystal bodies. The bodies of present commercial interest underlie an area of about 32 square miles and contain an estimated 100 million tons of alkali salts per square mile.[188] The main body averages 71 feet in thickness and is exposed over a 20-square mile area, roughly circular in outline and near the center of the lake.

Peripheral to the main body are other salt bodies as much as 30 feet thick [189] and covered by playa mud. The main body is successively underlain by an impervious mud layer 10 to 15 feet thick and another salt body about 35 feet thick, which contains abundant mud lenses. Recent drill holes, none more than 300 feet deep, show the lower salt body to be underlain by mud containing various carbonates or sulphates of calcium and/or magnesium. Along the eastern and northeastern margin of the lake is a crusted efflorescence, several feet thick, composed mostly of trona. This layer, known as "Trona Reef," was formerly mined by stripping operations.

The main crystal body consists chiefly of halite ($NaCl$), hanksite ($9Na_2SO_4 \cdot 2Na_2CO_3 \cdot KCl$), glaserite ($3K_2SO_4 \cdot Na_2SO_4$), trona ($Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$), and tincal or borax ($Na_2B_4O_7 \cdot 10H_2O$). The internal structure of the body is characterized by layers, lenses and irregular masses, each composed almost wholly of one or another of these minerals. About 50 percent of the volume of the body consists of pore space through which the lake brine circulates.

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187 Gale, H. S., Salines in the Owens, Searles, and Panamint basins, southeastern California: U. S. Geol. Survey Bull. 580, pp. 251-323, 1912.
188 Gale, W. A., Chemistry of the Trona process from the standpoint of the phase rule: Industrial and Engineering Chemistry, August, 1938.
189 Ryan, J. E., Industrial salts: production at Searles Lake: Am. Inst. Min. Met. Eng. Trans., Tech. Pub. 3063 H., pp. 447-452, 1951.

Bristol Lake. Bristol Lake, recently and thoroughly described by Gale,[190] covers an area of about 60 square miles just south of Amboy. It occupies the center of a broad depression, bordered mainly by ranges of pre-Cretaceous crystalline rocks, but flanked on the northwest by flows of Recent basaltic lava which emanated from Amboy crater about 3 miles west of Amboy.

Exploration by scattered drill holes shows a series of beds of crystalline rock salt intercalated with playa-type sediments, including some thin beds of light volcanic ash. The thickness of the salt beds ranges from a few inches to as much as 9 feet. A drill hole in the center of sec. 34, T. 5 N., R. 12 E., S.B.M. was completed early in 1952 to a depth of 1005 feet. Cores recovered to a depth of 950 feet showed that the series of sediment and salt beds continued at least to that depth.

The rock salt deposit of present commercial interest is an extensive horizontal layer as much as 7 feet thick, and covered by 3 to 7 feet of overburden. It is believed possible to mine the salt profitably over an area of 5 square miles in the northwestern part of the lake where the salt layer exceeds 3 feet in thickness. Bordering this area on the south is the depression's lowest part, known as Salt Lake and covered with a thin crust of rock salt. Plants recovering calcium chloride from the brines of Salt Lake have produced common salt as a by-product.

Gypsum, although occasionally found in layers at depth, is most abundant in deposits at or near the surface. According to Hess [191] the largest gypsum concentrations lies along the northwest border of the lake near the front of the lava flow. Here gypsiferous layers, 8 feet or more in thickness, have been encountered.

Celestite ($SrSO_4$), in nodular, potato-like masses, occurs in mud close to or on the lake surface, and is particularly abundant along the south side of the lake. According to Gale [192] these masses appear to be chemical precipitates, perhaps segregated by shallow ground water conditions.

Permeating the sediments and crystal bodies of Bristol Lake are brines which, from place to place, differ somewhat in their concentration and chemical composition. At several localities, particularly at Salt Lake and the bordering salt excavations, the brines are rich in calcium chloride, an unusual constituent for desert saline deposits. Brine samples taken from the 1005-foot drill hole mentioned above contain approximately the same proportion of calcium chloride as is found in the brine from surface excavations. Gale [193] suggests that the chlorine is of volcanic origin and that it was probably derived from the same source as that of the Amboy Crater lava.

The brine in the crystal body of Bristol Lake is collected by a series of drainage canals which are dug through the uppermost layer of salt. Solar evaporation of the brine causes precipitation of sodium chloride and concentration of calcium chloride in the liquor. Details of the salt and calcium chloride recovery operation are described in the individual property reports in the text to follow.

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[190] Gale, H. S., Geology of the saline deposits, Bristol Dry Lake, San Bernardino County, Calif.: California Div. Mines Special Rept. 13, 21 pp., 1951.
[191] Stone, R. W., and others, Gypsum deposits of the United States: U. S. Geol. Survey Bull. 697, pp. 81-82, 1920.
[192] Gale, H. S., op. cit., p. 10.
[193] Gale, H. S., op. cit.

Dale Lake.[194] Dale Lake, about 25 miles south of Bristol Lake, is the smallest of the five principal saline-bearing playas in San Bernardino County. Its surface covers an area of 4 to 5 square miles. Drilling at Dale Lake has been confined to an area of about one square mile. That the lake beds contain extensive salt bodies composed almost wholly of sodium sulfate (thenardite) and sodium chloride was first noted by Mr. Irving E. Bush who, in the period 1920 to 1924, drilled a number of test holes to depths of as much as 150 feet. Holes sunk by later operators are mostly 250 feet deep. The deepest is 308 feet.

The drilling has disclosed a succession of shaly layers alternating with layers of salts as much as 70 feet thick. Although individual strata of salts show marked variations in thickness, and do not persist laterally, the thickest salt bodies noted to date lie in two zones; one at a depth of 20 to 40 feet, the other at about 120 feet. The upper zone averages about 30 feet thick, the lower zone about 100 feet thick. These zones may extend beyond the area drilled; others of comparable sizes may exist at lower levels.

The salt beds range in composition from nearly pure sodium sulfate (thenardite) to nearly pure sodium chloride, but most are mixtures of the two minerals. Analyses of numerous salt samples averaged about 60 percent Na_2SO_4, 30 percent NaCl, and 10 percent insoluble constituents. The typical brine obtained during pumping operations (see description of Dale Chemical Industries, Inc.) ranged from 7.5 to 8.0 percent Na_2SO_4, and from 20.0 to 22.0 percent NaCl.

Danby Lake. Danby Lake is about 12 miles southeast of Cadiz. Although much less thoroughly explored than Bristol Lake, it is similar in that it contains extensive deposits of sodium chloride as well as marginal accumulations of gypsum. Danby Lake is about 10 miles long and 2 to 3 miles wide.

The easily recoverable sodium chloride is confined to a single, shallow layer, which, over an area of 8 to 16 square miles, ranges from a foot to as much as 10 feet thick. It is covered by a few-inch to 8-foot overburden. Analyses of the salt rock consistently show more than 97 percent sodium chloride.

The brine, commonly encountered within 4 or 5 feet of the surface, has a sodium chloride content of 11.6 to 31.6 percent and very small proportions of other salts.

Cadiz Lake. Cadiz Lake about 12 miles east-southeast of Danby Lake contains extensive deposits of saline minerals, principally sodium chloride and gypsum, but remains relatively unexplored. Their remoteness has hindered the development of the deposits. The lake brine, like that of Bristol Lake is rich in calcium chloride and in 1952 was attracting attention as a possible future source of this material.

Boron[195]

In 1862 John W. Searles, while prospecting in northwestern San Bernardino County, noted occurrences of borax on the surface of a large

[194] Data on the Dale Lake salines have been kindly furnished by Mr. John M. Fox, Consulting Mining Engineer.

[195] Most of the boron data contained herein has been kindly furnished in personal communication by H. S. Gale. Additional information was obtained from various volumes of Mineral resources of the United States.

playa, later to be known as Searles Lake. This is believed to have been the first discovery of borate in the county. The deposits remained undeveloped until 1873 when Mr. Searles, upon realizing their probable value, located, with E. M. Skillings, a group of claims along the northwest border of the salt-crusted lake surface.[196] These deposits were worked from 1874 to about 1890, finally to prove non-economic with the development of the colemanite deposits near Calico in the west-central part of the county. The early Searles Lake surface operations were contemporaneous with other similar operations in California and Nevada.

The Calico colemanite deposits, opened in 1884, were worked on a large scale until 1907 when the Pacific Coast Borax Company, the principal producer, transferred its operations to other colemanite deposits at the Lila C mine near Death Valley Junction, Inyo County. Although this action was caused by the near depletion of the easily recoverable reserves at Calico, the Pacific Coast Borax Company continued to purchase borates from other operators in the Calico district until the mid-twenties when the opening of the famous Kramer deposits in Kern County rendered the mining of all colemanite unprofitable. During their most active period, the Calico colemanite mines were the world's principal source of borate: Cloudman [197] has placed the total value of their output at over $9,000,000.

In the period 1893-1908 much interest was shown in the extraction of low-grade borate from siltstone and shale exposed in the Calico-Daggett area. For this purpose three plants were constructed in the area. One operated for several years, but with difficulty. The others were shorter lived. All employed a process wherein borate was leached from the shale with sulfuric acid, and the liquor evaporated in vats. The process, though effective, proved too expensive to meet the lowered price of borax that came in 1907-1908 with the opening of the Lila C mine.

In the early 1900's attention was again directed toward Searles Lake as a borate source when several concerns attempted the removal of potash salts and borax from the lake brine. The American Potash and Chemical Company, described in potash section of this report, became a producer. Since 1926 the West End Chemical Company, described in the sodium carbonate section, also has been a significant borax producer.

Searles Lake Surface Operations. According to Hake [198] the early borax operations at Searles Lake were confined to a 300-acre area underlain by a hard, saline crust about one foot thick, composed mostly of carbonate and sulfate of soda, and containing about one percent borax. Mud underlying the crust was said to contain nests of saline crystals (sodium carbonate, common salt and borax) to a depth of 3 to 4 feet. Most of the raw material for borax manufacture was obtained from an efflorescent layer, on the surface of the crust, composed of 50 percent sand, 12 percent borax and about equal proportions of sodium sulfate, sodium carbonate, and common salt. The entire area was ordinarily covered with a few inches of water. Material from the efflorescent layer was scraped

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[196] Hake, C. N., An account of Borax Lake in California: Journ. Soc. Chem. Ind., Nov. 30, 1889, pp. 854-857.

[197] Cloudman, H. E., Huguenin, E., and Merrill, F. J. H., San Bernardino County: California Min. Bur. Rept. 15, pp. 775-899, 1919.

[198] Hake, C. N., op. cit.

FIGURE 41. Eastern part of colemanite-bearing zone in Calico Mountains. Formerly worked by Pacific Coast Borax Company. Colemanite in white "borate shale" low on slope. Andesite underlies higher part.

into windrows and carted two miles to the plant. Here the borax was taken into solution in steam boiling tanks, and recrystallized in vats.[199]

Deposits of the Calico District.[200] Concentrations of borate minerals in the Calico district are confined to shaly strata in the upper part of a Tertiary section composed of tuff, lava, agglomerate, and lacustrine sedimentary rocks. The section, possibly as much as 5000 feet thick, lies with depositional contact upon pre-Tertiary granitic rocks. The Tertiary section consists of 1) a basal unit of rhyolitic to andesitic tuff and agglomerate, 2) a middle unit of rhyolite and andesite flows and agglomerate layers, and 3) an upper sedimentary unit of chert, limestone, arkosic sandstone, shale, and tuff. The upper unit is believed to be equivalent to the lower part of the Miocene Barstow formation, or to rocks older than the Barstow.

The borate-bearing strata are shaly lake beds, known locally as ''borate shale'', that lie near the top of the sedimentary unit. Borate shale is rather widely exposed in the Calico-Daggett area but only in the eastern part of the Calico Mountains has it been observed to contain colemanite bodies of commercial interest. Ordinarily the contained borates are finely divided and intimately mixed with shaly matter.

The principal colemanite occurrences lie along the northeast slope of Red Mountain. They are enclosed mostly in gray shale and lie at two or three horizons separated by a stratigraphic thickness of about 50 feet. The deposits and the shale strike westward and, in general, dip moderately to steeply southward. According to Bailey,[201] who observed the deposits as they were being worked, the colemanite-bearing material had the appearance of indurated mud or fine-grained limestone. It occurred in irregular, pockety bodies and was being mined through thicknesses of 7 to 10 feet. Bailey states that the colemanite (probably in reference to mine-run ore) contained from 15 to 20 percent anhydrous boric acid. At the Centennial mine, high on the south slope of Red Mountain, are other colemanite occurrences said to have yielded a small tonnage of ore. Storms,[202] in an earlier description, noted the occurrence of colemanite in large glassy crystals.

By far the largest borate operations in the Calico-Daggett area were those at Old Borate, where the Pacific Coast Borax Company held 28 claims covering the known colemanite exposures in the principal belt. Most of the claims lie in a broad arc, convex northward, and extending eastward from the eastern part of sec. 23, T. 10 N., R. 1 E., to the center of sec. 20, T. 10 N., R. 2 E., S.B.M. As noted above, the company's mining activity extended from 1884 to 1907, but for nearly 20 years afterward it continued to purchase small tonnages of colemanite from others who undertook scavenging operations. There is probably no record of the actual extent of the mine workings. They exist along a belt about $1\frac{1}{2}$ miles long, and consist of numerous inclined shafts, drifts, and crosscuts that appear to honey-comb the colemanite-bearing strata. The most

[199] Hanks, H. G., Report on the borax deposits of California and Nevada: California Min. Bur. Rept. 3, pt. 2, pp. 15-26, 1883.
[200] Most of this description has been obtained in personal communication with H. S. Gale and from the following reference: Erwin, H. D., and Gardner, D. L., Notes on the geology of a portion of the Calico Mountains, San Bernardino County, California: California Div. Mines Rept. 36, pp. 293-304, 1940.
[201] Bailey, G. E., The saline deposits of California: California Min. Bur. Bull. 24, 1902.
[202] Storms, W. H., San Bernardino County: California Min. Bur. Rept. 11, pp. 345-348, 1893.

extensive workings are in the northern parts of sections 19 and 20. In 1896 the deepest workings were said to extend 500 feet from the surface.[203]

Other operations intended to develop colemanite were the Centennial mine and the Union workings. Four workings developed occurrences of borate shale. One of the borate shale operations was that of the Palm Borate Company on property from one-half to $1\frac{1}{2}$ miles south of the main colemanite zone; another, the mine of the Western Mineral Company, was immediately southeast of the town of Calico; another, the American Borax Company mine, was at the foot of the north slope of Lead Mountain between Yermo and Barstow; the fourth was Columbus Borax Company mine about $4\frac{1}{2}$ miles south of Daggett.

The Centennial mine on one of a group of three claims is said to have been once owned by the Pacific Coast Borax Company and to have yielded 600 to 700 tons of colemanite in a belt of black shale with an exposed length of at least 250 feet. The shale strikes N. 57° E. and dips 20° to the northwest. The colemanite occurs as irregular lumps in a chalky white, howlite (?) matrix distributed along a single zone in the shale. Workings consist of several open cuts, and some minor underground developments.

The Union Borax Company, a subsidiary of the Standard Sanitary Company of Pittsburgh, Pennsylvania, and under the direction of Messrs. Blumenburg, Dawes and Myler, was active in the Calico district in 1919 and 1920. A shaft, near the middle of the east side of sec. 19, probably 640 or more feet deep and sunk from a point several hundred feet south of the main colemanite-bearing zone, is said to be wholly in Red Mountain andesite. A north-trending crosscut is believed to extend from the shaft but to have encountered little or no colemanite. However, colemanite and howlite may be seen today on the dump.

The Palm Borate property, consisting of nine patented claims, covers exposures of gray shale on the east side of Red Mountain. The first work, probably concurrent with the most active period of mining along the main colemanite-bearing zone, appears to have been in search of similar colemanite occurrences. The workings consist of tunnels now largely caved, in which no mineable colemanite bodies were encountered. Much of the shale mined, however, was borate-bearing; large masses probably averaged 5 to 8 percent anhydrous boric acid.

In 1904 the name ''Palm Borate Company'' was adopted, and plans were laid for the construction of a mill to remove borate from the shale. The plant, designated to leach borate with sulfuric acid and recover the borate in evaporating vats, was constructed on the property and completed probably in 1907. The plant is said to have operated for only 10 days when a decline in the price of borax forced its closing and the later liquidation of the company.

The operations of the Western Mineral Company included a shale treatment plant and the mine, near Calico, mentioned above. Prominent in the company was W. P. Bartlett who entered the Calico district in mid-1897 to become a pioneer in the borate shale operations. A total investment of about $140,000 yielded not more than 500 tons of 95 percent boric acid before the plant was shut down in 1907. The process was similar to that employed in other borate shale plants of the area.

[203] Crawford, J. J., California Min. Bur. Rept. 13, p. 47, 1896.

The Western deposit consists of a body of bedded siltstone and sandstone, 25 to 30 feet thick, striking northeast and dipping about 30° northwest. It is said to average 10 percent anhydrous boric acid and to contain stringers of howlite, celestite, and gypsum. The body was developed by an inclined shaft, believed to be 200 feet long, with appended drifts in both directions at 50-foot intervals.

The American Borax Company property, covering six claims north of Lead Mountain, was actively worked during the period 1900-1907 under three successive operators. Virtually all of the borate production was obtained in operations of the American Borax Company extending from 1904 to 1907. An extraction plant was in Daggett.

The raw material was mined from borate-rich layers in a poorly exposed shaly unit. Although the borate was not megascopic, certain beds were found to contain 8 to 14 percent anhydrous boric acid. The mine workings, which are confined to a layer from 15 to 20 feet thick in its surface exposures, consist of several open cuts and an inclined shaft said to be 400 feet long and joined to about 1000 feet of drifts. The shale was removed from overhand stopes. The plant was similar in design to those of other borate shale operation in the area.

The Columbus or Gem borate mine, on a 60-acre patented claim about 4½ miles south of Daggett, is believed to have been first worked in 1897 or 1898. At about this time the Columbus Borax Company erected a plant at Bayonne, New Jersey to treat colemanite ore from its property in Ventura County, California. This plant may also have treated a small tonnage of borate shale from the Columbus mine, but most of the mine's output was obtained by W. P. Bartlett (see Western Mineral Company) for the Stauffer Chemical Company and under a working agreement with Columbus Borax Company. The Bayonne plant was eventually acquired by the Pacific Coast Borax Company which operated it for many years.

The Columbus mine workings are in a west-trending belt of shaly beds exposed in an area of low relief. Also within the belt are subordinate proportions of sandstone and limestone. The borate-bearing beds that were of commercial interest appear to have been largely removed in the mining. Most of the borate shale mined probably contained from 8 to 18 percent anhydrous boric acid although some carload shipments are said to have contained as much as 30 percent. The main workings consist of a 150-foot shaft with drifts at the 50-foot and 100-foot levels.

Bromine

The brine from the upper salt structure at Searles Lake, as treated at the Trona plant of the American Potash and Chemical Corporation, is the only current source of bromine in San Bernardino County. As described in the potassium salts section of this report, the bromine is recovered as a by-product of a process in which muriate of potash is refined from agricultural grade to chemical grade.

Calcium Chloride

Calcium chloride is a major constituent of the brine contained in the crystal bodies of Bristol and Cadiz dry lakes but has been recovered commercially only from Bristol Lake. The first claims on the saline deposits of Bristol Lake were located for calcium chloride in 1908. Although they were placed in operation in 1910, the output previous to 1921 was

unrecorded by the State Mining Bureau.[204] The total production of calcium chloride from Bristol Lake during the period 1912 through 1951 has been estimated to be 275,100 tons.[205]

The following analysis of Bristol Lake brine was reported by Gale.[206]

	Percent
Calcium	25.30
Magnesium	1.10
Sodium	23.60
Bicarbonate	0.05
Chloride	49.91
Sulfate	0.04

The high calcium chloride content thus shown is unknown in the brines of other California lakes or playas, except in the Cadiz Lake brine which is similar in composition.

Three companies now produce calcium chloride from Bristol Lake. One of these, the California Salt Company is also a salt producer. Its operations are described in this report under the heading of salt. The operations of the other two, the Hill Brothers Chemical Company and National Chloride Company of America, are described below. The brine collects by drainage into ditches cut in "Salt Lake," the lowest part of the Bristol Lake playa.

Hill Brothers Chemical Company. Location: sec. 11, T. 5 N., R. 12 E., S.B.M., at Saltus adjacent to the California Salt Company plant 3 miles east of Amboy. Ownership: Hill Brothers Chemical Company, C. B. Hill, president, 2159 Bay Street, Los Angeles, California owns a plant on land leased from the California Salt Company.

The Hill Brothers Chemical Company started the production of flake calcium chloride about 1940. The plant has since operated almost continuously and has produced about 56,000 tons of flake or solid calcium chloride.

The company purchases brine, having an average gravity of 40° Baumé, from the California Salt Company; the sodium chloride content of the brine has been partly precipitated in solar evaporation ponds. The plant operation consists of dehydrating this brine by heating in two open vats to a point where the remaining sodium chloride has precipitated and the brine is saturated with calcium chloride. A small stream of the saturated brine is discharged over a rotating steel drum inside of which cold water is circulated. The brine is chilled and solidified, and the cake formed is peeled off the drum in flakes which are cooled, bagged in 100-pound water-proof bags, or put into 375-pound drums. Some saturated brine is discharged directly into drums which hold a 700-pound cake of solid material. After the vats are drained of the calcium chloride solution, the precipitated sodium chloride is cleaned out of the vats prior to the next run.

About 15 or 20 tons of calcium chloride is produced per day; the product is not completely anhydrous but is designated as 75 percent $CaCl_2$. About 6 pounds of calcium chloride is obtained from a gallon of brine.

In 1952 the company was also prospecting areas on Cadiz Dry Lake for brine suitable for a similar calcium chloride operation.

[204] Bradley, W. W., California mineral production for 1922: California Min. Bur. Bull. 93, p. 141, 1923.
[205] Biedebach, W. F., California Salt Company, personal communication, 1952.
[206] Gale, H. S., op. cit., p. 10.

FIGURE 42. Brine in drainage canal leading north toward calcium chloride plant of National Chloride Company on Bristol Dry Lake. Bristol Mountains in background.

National Chloride Company of America (Hollar Chemical Company, Saline Products Company). Location: secs. 1 through 15, T. 4 N., R. 12 E., secs. 29 through 36, T. 5 N., R. 12 E., secs. 7 and 8, T. 4 N., R. 13 E., S.B.M., on the west side of Bristol Lake south of Amboy. Ownership: The National Chloride Company of America, P. T. Beeghly, president, M. M. Stephens, vice-president, 354 South Spring Street, Los Angeles, California, owns more than 12,000 acres.

The property now held by the National Chloride Company of America was formerly held by the Saline Products Company, also known as the Hollar Chemical Company, which was active in the 1930's. The Desert Properties Company gained control in 1939 and produced calcium chloride as recently as 1949. In June 1950 the property was acquired by the National Chloride Company which has since operated it continuously.

The brine in the crystal body of Bristol Lake is collected by a series of drainage canals dug through the uppermost layer of salt and leading to a sump. The brine is pumped from the sump to several large, shallow solar evaporation ponds whose bottoms are the upper surface of the first salt bed.

Evaporation of the brine from a gravity of about 19° Baumé to about 36° Baumé [207] causes sodium chloride to precipitate and calcium chloride

[207] Gale, H. S., op. cit., p. 9.

to concentrate in the liquor. When the brine reaches a density of 40° Baumé, it is pumped to a storage basin from which tank trucks are loaded. The brine is hauled to Amboy for storage and rail shipment. The evaporation cycle takes an average period of two weeks.

The precipitated sodium chloride is stockpiled along the banks of the evaporating ponds. A plant in the SE¼ sec. 32, T. 5 N., R. 12 E., set up to make solid or flake calcium chloride was inactive early in 1952 but may be rehabilitated. The calcium chloride is sold in liquid form; about 10 tank cars per month are produced.

Gypsum

Although gypsum deposits of possible commercial interest exist at several localities in San Bernardino County, only the Amboy deposits at Bristol Lake have been seriously worked. Since this operation was shut down in 1924, there has been no recorded production of gypsum in the county. Of the unexploited gypsum occurrences, probably those with the largest reserves are the Avawatz deposits, along the north base of the Avawatz Range, the Shire deposits northeast of Clark Mountain, and deposits at Danby Dry Lake.

With the exception of the Shire deposits, all of the known gypsum occurrences that have been prospected or mined in the county occur in Tertiary or Quaternary formations and are interbedded with shale and siltstone. The Shire deposits are part of the Permian Kaibab formation.

Gypsum concentrations range from beds an inch or less thick, in rock composed mostly of shale or siltstone, to layered units as much as 150 feet thick, of which the clay or siltstone fraction is very small. Development has been hindered by the remoteness of the large deposits from rail transportation.

Amboy Deposits. Location: secs. 3, 4, 8, 10, 11, 17, 19, 20, 29, 30, T. 5 N., R. 12 E., S.B.M., along the northwest side of Bristol Lake and extending about 5 miles south and 3 miles southeast of Amboy. Ownership: U. S. Gypsum Company, Chicago, Illinois, owns 23 patented placer claims covering 1,822 acres.

The Amboy gypsum deposits were put into production in 1906 by the Consolidated Pacific Cement Plaster Company. From then until this operation was suspended in 1924, the deposits supplied gypsum to the largest plaster mills in California.

The gypsum occurs in a belt a mile or less wide along the northwest margin of Bristol Dry Lake.[208] In general, the gypsum appears most abundant near the front of a basaltic lava flow extending eastward from the Amboy crater. The material was removed from shallow excavations 6 to 8 feet in maximum depth. The gypsum beds may be even thicker but deeper excavation was prevented by a shallow water table. The gypsum occurs as a mush of selenite crystals mixed with various proportions of salty mud. This material was carried to a plaster mill, about 2 miles southeast of Amboy, where most of the salt and mud was removed and the gypsum was calcined and prepared for shipment.

Avawatz Deposits. Location: sec. 30, T. 18 N., R. 6 E., sec. 5, 6, 8, T. 17 N., R. 6 E., secs. 1, 2, 3, T. 17 N., R. 5 E., secs. 16, 19, 20, 21, 22, 23, 26, 27, 28, 29, 34, 35, 36, T. 18 N., R. 5 E., S.B.M. (projected), low along

[208] Gale, H. S., Geology of the saline deposits of Bristol Dry Lake, San Bernardino County, California: California Div. Mines Special Rept. 13, pp. 5, 6, 1951.

north flank of Avawatz Range, and about 30 airline miles northwest of Baker. Ownership: Avawatz Salt and Gypsum Company, 2545 Raleigh Drive, San Marino, California, owns 22 patented placer claims and 5 patented lode claims.

Extensively exposed along a 9-mile, northwest-trending belt in the northern foothills of the Avawatz Range, are highly deformed Tertiary lake beds containing gypsum, salt, and celestite. Also in the belt are blocks of older crystalline rocks. One such block, in the Sheep Creek area, contains the talc deposits noted in the following section. The saline deposits have been partly to thoroughly explored, but remain to be actively worked.

Although the deposits were studied in detail as early as 1911,[209] and in several succeeding investigations, the Tertiary stratigraphic succession and much of the structure has been interpreted differently.

In brief, the Tertiary sediments and crystalline rocks occur in a series of blocks or slivers bounded by steeply dipping faults. Most of the faults belong to a northwest-trending series that projects from the Avawatz Range into the southern end of Death Valley. In the Sheep Creek area, at the east end of the saline-bearing belt, these faults join the Garlock fault zone which trends eastward.

The belt, in general, consists of three elongate and adjacent slivers. The central sliver, mostly from half a mile to three-quarters of a mile wide, consists of Tertiary (?) breccia containing fragments of the crystalline rocks that comprise the core of the Avawatz Range. The bordering slivers are composed of highly folded and faulted Tertiary lake beds which contain the saline-bearing units and are probably of upper Miocene or lower Pliocene age.

Lewis and Johnson, as cited by Ver Planck,[210] recognize the following four-fold subdivision of the Tertiary lake beds: 1) a unit composed of saline-free, maroon to deep red shale and sandstone about 250 feet thick and grading upward into 2) a unit, 150 to 400 feet thick, composed of alternating layers of gypsum and yellow gypsiferous clay, 3) a red to yellow unit of salty clay and rock salt of undetermined thickness and grading upward into 4) a unit, 300 feet thick, of pebbly sandstone with a minor proportion of gypsum and salt. The lake beds are overlain with marked angular unconformity by fanglomerate, probably of late Pleistocene to Recent age.

From place to place, gypsum beds comprise from a small fraction to as much as two-thirds of the gypsiferous unit. Of particular economic interest are exposures at the West End area, northwest of Denning Spring, showing 150 feet of beds in which gypsum layers as much as one foot thick are separated by much thinner layers of clay. Gypsum is comparably abundant in the Salt Basin area in the central part of the main saline-bearing belt. In the Jumbo area, southeast of Salt Basin, gypsum of possible commercial interest occurs in a relatively clay-free layer 20 to 30 feet thick. In the Sheep Creek area also, much of the gypsiferous unit contains a rather small clay fraction.

Rock salt is as extensive as the gypsum and ordinarily occurs near the center of the salty clay unit. Because the salt-bearing unit characteristically is deformed and poorly exposed, its true thickness is not clearly

[209] Lewis, J. O., and Johnson, H. R., unpublished report prepared for the Avawatz Salt and Gypsum Company, July 1911.
[210] Ver Planck, W. E., Gypsum in California: California Div. Mines Bull. 163.

shown. In an exploration project undertaken in 1941 and 1942 by Basic Magnesium, Incorporated, the salt deposits of the Barstow-Valley claims near Denning Springs Wash were penetrated by 27 diamond drill holes. This project is said to have revealed a large tonnage of salt averaging 92 or more percent NaCl.[211] Extensive exposures of salt also exist on the King Salt, Salt Basin and Jumbo claims, but have not been as thoroughly explored. The total salt reserves of the area are believed to total millions of tons.

Celestite, in nodules and layers as much as three feet thick, occurs in the lower part of the gypsiferous unit near Denning Spring Wash. The celestite-bearing zone can be traced laterally for about 1000 feet.

The saline-bearing belt has been explored by numerous cuts, pits, and shallow adits, in addition to the diamond drill holes noted above.

Red Canyon Deposits. Location: sec. 17, T. 17 N., R. 10 E., S.B.M., near Eastern Star Wash in the west-central part of Shadow Mountains, and about 12 miles north-northeast of Baker. Ownership: Jerry Korfist and Frank Curtis, Baker, California, own two claims.

The Red Canyon deposits, located in 1951 by the present owners, may be the same as the Couchman deposits briefly noted by Tucker and Sampson.[212] The deposits consist of gypsum layers in a yellow, Tertiary siltstone which is exposed in a northwest-trending belt about 2000 feet long. Most of the gypsum is in a 500-foot westerly segment of the belt. The Tertiary strata strike northwest and, in general, dip vertically.

Although the gypsum-bearing part of the section appears to be several hundred feet thick, most of the gypsum is in irregularly and sparsely distributed beds and seams less than 4 inches thick. The largest exposed individual body is about 6 feet in maximum width and about 70 feet in exposed length. Development consists of several open cuts and a 70-foot, southwest-trending adit that cross-cuts strata relatively barren of gypsum.

Shire Deposits.[213] Location: sec. 36, T. 18 N., R. 13 E., S.B.M., and sec. 24, T. 17½ N., R. 13 E., S.B.M., on a ridge extending northward from Clark Mountain, and about 10 airline miles north of Mountain Pass. Ownership: D. H. Shire, 323 West Florence Avenue, Los Angeles, California, owns eight claims.

The Shire deposits, though poorly exposed and developed only by a few trenches, appear to comprise one of California's larger gypsum reserves. Like the extensively worked deposits near Arden, Nevada, the Shire gypsum occurs as massive beds forming part of the Kaibab (Permian) formation. The gypsum, interbedded with cherty limestone, sandy limestone and shale, is discontinuously exposed for a distance of one to two miles low on the talus-covered, southwest side of a wash. Here the formation strikes about N. 40° W. and dips 50° southwest.

The gypsum, generally a white, sugary aggregate, comprises layers ranging from a fraction of an inch to at least 50 feet thick. The thicker

[211] H. H. Kerckhoff, personal communication, 1951.

[212] Tucker, W. B., and Sampson, R. J., Los Angeles field division, San Bernardino County: California Div. Mines Rept. 26, p. 307, 1930, also California Div. Mines Rept. 27, p. 387, 1931.

Tucker, W. B., and Sampson, R. J., Mineral resources of San Bernardino County: California Div. Mines Rept. 39, p. 516, 1943.

[213] Most of the data in this description were furnished by W. E. Ver Planck, Assistant Mining Geologist, California Division of Mines.

layers underlie the lower slopes and perhaps extend beneath the wash. Higher in the formation the gypsum proportion progressively decreases.

Lithium

The only lithium currently produced in California is obtained as a by-product of the operations of the American Potash and Chemical Corporation at Trona. This operation, described in the potash section, yielded as much as 150 tons of di-lithium sodium phosphate each month. In 1952 the plant was converted to produce lithium carbonate instead.

Magnesium Salts

From 1922 to 1926 an attempt was made to develop a deposit of magnesium sulfate and magnesium carbonate about 20 miles east of Searles Lake. These salts occur in surface encrustations and in underlying Tertiary sedimentary rocks. Although a 30-mile monorail line was built between the mine and a rail siding south of Trona, the operation proved unsuccessful and most of the installations were dismantled.

Nitrates

The occurrence of nitrates in the desert regions of San Bernardino and Inyo Counties has been known for many years. During World War I a systematic search for commercial deposits of nitrate was made by the U. S. Geological Survey. The Amargosa region was studied first and the results published in 1922.[214] Results of the subsequent surveys of other deposits in the area were published in 1931.[215] Neither report indicates nitrate deposits of commercial value.

Potassium Salts

The plant of the American Potash and Chemical Corporation, at Trona on the margin of Searles Lake, is the only current source of potash in California. This operation has a daily yield of about 650 tons of muriate of potash. As noted above, during the period 1916-1920 potash was also recovered at the plant of the Solvay Process Company also at Searles Lake.

Trona (American Potash and Chemical Corporation). Location: T. 25 S., R. 43 E., T. 26 S., R. 43 E., T. 25 S., R. 44 E., T. 26 S., R. 44 E., M.D.M., holdings covering most of northern half and much of the southern half of Searles Lake playa. Ownership: American Potash and Chemical Corporation, 70 Pine Street, New York, New York, owns patented claims covering 2560 acres in the northern part of the lake, and leases 3400 acres from the federal government. One 840-acre lease is contiguous with the patented claims; two 1280-acre leases are at the south end of the lake.

The Trona plant of theAmerican Potash and Chemical Corporation, as recently described by Ryan,[216] represents a 32 million dollar investment, employs about 1500 workers, and has a daily output of 1800 tons of various salts of sodium, potash, boron, lithium, and bromine, as well as liquid bromine and boric acid.

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[214] Noble, L. F., Mansfield, G. R., and others, Nitrate deposits in the Amargosa region, southeastern California: U. S. Geol. Surv. Bull. 724, VII, 99 pp., 1922.

[215] Noble, L. F., Nitrate deposits in southeastern California, with notes on deposits in southeastern Arizona and southwestern New Mexico: U. S. Geol. Surv. Bull. 820, 108 pp., 1931.

[216] Ryan, J. E., Industrial salts: production at Searles Lake Min. Eng., vol. 3, no. 5, pp. 447-452, May 1951. This reference was the principal source of information contained in this section.

FIGURE 43. Aerial view of American Potash and Chemical Corporation plant on Searles Lake at Trona. West edge of Searles Lake in foreground. *Photo courtesy American Potash and Chemical Corporation.*

The holdings of the American Potash and Chemical Corporation probably include the area originally located by John W. Searles following his discovery in 1862 of borax on the lake surface. In 1873 Mr. Searles began the recovery of borax by leaching the playa crust and recrystallizing the salts.[217] This operation, which in 1878 was incorporated as the San Bernardino Borax Mining Company, continued until 1895 when the property was purchased by the Pacific Coast Borax Company.

In the period 1905-1906, the California Trona Company was formed and began an attempt to produce trona from the Trona Reef and from lake brine. The operation failed, but the Company retained a number of patented claims on the north-central part of the lake. Attracted by the announcement in 1912 of the discovery of potash in the lake beds and brine,[218] the American Trona Corporation acquired the holdings of the California Trona Company. A plant designed to recover sodium carbonate and potassium chloride from the brine was completed in 1914, but was unsuccessful.

Stimulated by the potash shortage of World War II, several concerns constructed other pilot plants to recover the potash. The American Potash and Chemical Company, which purchased the property of the American Trona Corporation, was the only one to become a continuing producer of potash. Another, the Solvay Process Company, operated at Borosolvay from 1916 to 1920.

Although the availability of foreign potash caused the Searles Lake material, as it was first produced, to be uneconomic, an intensive research program by the American Potash and Chemical Company has led to the current success of the operation. In 1934 the Company constructed a plant to recover soda ash and salt cake from salts previously wasted in the production of potassium salts and borax. In 1946 the lower crystal body was discovered. As it was found to be richer in sodium carbonate and borax, and poorer in potassium salts than the higher body, a carbonation plant was built to treat this brine independently as a source of soda ash and borax.

In the present operation, as in the past, brine is obtained from holes drilled in the lake beds and penetrating the two crystal bodies noted in the introductory part of the saline section of this report. Several hundred holes have been drilled. In recent years the sinking of exploratory holes, as well as brine-producing wells, has become part of a carefully planned program. In a study of the character of the brine, the rate and direction of its flow, and the influence of pumping upon its composition, pattern drill holes have been sunk at half a mile intervals to depths of about 150 feet. Upon completion of a hole, brine samples are taken at regular time intervals and at various depths; movement is detected by fluorescent dye color tests.

Brine-producing wells are spaced at 500-foot intervals. A group of 34 wells draws daily about 17,000 tons of raw brine from the upper salt body. About 8,000 tons of brine is pumped each day from the lower salt body by a group of eight wells. The average compositions of the brines thus obtained are shown in table 1. The two brines are treated separately. The upper structure brine is subjected to a cyclic process which involves the fractional crystallization of salts by evaporation and cooling. The lower

217 Teeple, J. E., The industrial development of Searles Lake brine, New York Chemical Catalogue Co., pp. 20-25, 1929.

218 Gale, H. S., Searles Lake: Mineral resources of U. S., 1912, pt. 2, pp. 884-885, 1912.

structure brine is treated by a carbonation process in which CO_2 from waste flue gas is used to precipitate bicarbonate of soda which is in turn calcined to soda ash. This is essentially the process employed at Searles Lake by the West End Chemical Company whose operations are described in a succeeding section.

In the cyclic process raw brine is mixed with process end liquors and fed into evaporators and crystallizer units. Heat is supplied by exhaust steam from turbo-generators driven by steam supplied by oil-burning boilers. Evaporation and heating causes a precipitation of sodium chloride, burkeite (a double sodium salt of carbonate and sulfate), and di-lithium sodium phosphate. The remaining liquor contains a concentration of potassium chloride and sodium tetraborate. The precipitated salts are removed from the saturated liquor by elutriation. The liquor, when discharged is at a temperature of 220° F.

*Table 1. Composition of the Searles Lake upper and lower structure brines.**

Constituent	Upper structure percent	Lower structure percent
KCl	5.02	2.94
Na_2CO_3	4.80	6.78
Na_2B_4O	1.63	1.96
Na_2SO_4	6.75	6.56
$NaCl$	16.06	15.51
Na_2S	0.08	0.38
Li_2O	0.015	0.006
KBr	0.12	0.08
WO_3	0.007	0.004
I_2	0.003	0.002
P_2O_5	0.070	0.044
F	0.002	0.002

* Quoted from J. E. Ryan, Industrial salts: production at Searles Lake: Min. Eng., vol. 3, no. 5, pp. 447-452, May 1951.

Potash is removed from the liquor by the crystallization of muriate of potash. This is effected by diluting, to prevent further crystallization of sodium chloride, and by rapidly cooling the liquor to 100° F. The muriate of potash crystals, which are nearly borate-free, are thickened, filtered, washed, and dried. In 1951 anhydrous muriate of potash was being produced at the rate of about 650 tons per days. Most is shipped as agricultural grade material (61 percent K_2O) : Some is recrystallized to chemical grade. The KCl solution is treated in Kubierschky-type towers to remove bromine which, in turn, is refined and marketed as liquid bromine or alkali bromides. Muriate of potash is also used in reaction with crude burkeite or sodium sulfate to produce potassium sulfate.

Borax is crystallized from the end liquor of the potash plant by cooling to 85° F. in vacuum ammonia-cooled crystallizers. After the sludge is filtered, the filter cake is brine-leached to remove soluble phosphate impurities and is refined by recrystallization. Some of the refined material is treated with sulfuric acid to produce boric acid; some is heated to fusion to produce crystalline anhydrous borax. In 1951 the plant yielded about 300 tons of borate each day.

Before salt cake, soda ash, and lithium are produced from the precipitate obtained at the main evaporators, the sodium chloride, being coarser than the burkeite and lithium salt, is first removed by hydraulic classification. The fines are filtered; the filter cake is washed and repulped in end liquors from the soda products plant. The burkeite is leached of

free sodium carbonate; the slurry is treated with sodium chloride in a hot saturator tank; and the burkeite solids are thickened, filtered and dissolved in water.

The resultant slurry passes through the lithium plant for the removal of the di-lithium sodium phosphate, which has remained in fine suspension. The burkeite liquor is then cooled to about 78° F. in crystallizers, permitting the precipitation of glauber salt. Anhydrous sodium sulfate is produced by mixing filtered glauber salt with sodium chloride in converter tanks.

Much of the residual sodium sulfate in the glauber salt filtrate is crystallized by first cooling the filtrate and then passing it into crude sulfate precipitator units where it is treated with sodium chloride. The sodium sulfate thus obtained is thickened, filtered, leached for chloride impurity, and further thickened. The thickener underflow is combined with the anhydrous sulfate noted above, and the mixture is filtered and dried. It has been produced at rates of as much as 600 tons per day.

In the production of soda ash the thickener overflow and the filtrate liquor, from the steps noted in the foregoing paragraph, are combined to become a hot carbonate liquor. After the sodium chloride is precipitated by cooling, sal soda is crystallized from the clarified liquor, filtered, and converted to sodium carbonate monohydrate in evaporators. The product is again filtered and calcined to commercial soda ash at the rate of about 300 tons per day.

The di-lithium sodium phosphate precipitated in the first evaporator, and freed from burkeite in the soda products process, is produced at the rate of about 150 tons per month. The precipitate, a very finely divided material, is recovered from the burkeite by a continuous flotation process. The burkeite liquor, to which fatty acid and mineral oil have been added, is aerated and passed into flotation tanks where the particles of lithium compound, which have a soap-oil coating, contact air bubbles, coagulate, and rise to the surface in a foam. The foam is sent to receiver tanks where it is de-aerated by heating, leached of its sulfate impurities, filtered and dried.

Salt

From 1912 through 1951 saline recovery operations on Bristol Dry Lake, currently the only source of salt in the county, have produced more than 1,630,000 tons of salt. The California Salt Company and its predecessors have produced more than 98 percent of this total. The California Salt Company excavates salt from the crystal body of the dry lake. Salt is also obtained as a by-product of operations recovering calcium chloride from the brine which permeates the crystal body.

Sources of salt which are not now being exploited include the brines and crystal bodies of Dale, Danby and Soda dry lakes. Cadiz Dry Lake is a potential source, but is now of most interest because of its calcium chloride-rich brine. Large tonnages of salt brine are discarded at the saline recovery plants of the West End Chemical Company and the American Potash and Chemical Company on Searles Lake.

Large reserves of crystal salt in the Avawatz salt and gypsum deposits were demonstrated by diamond drilling during an exploration program conducted by Basic Magnesium Incorporated in 1941-42. These salt deposits, associated with deposits of gypsum and celestite, are part of a

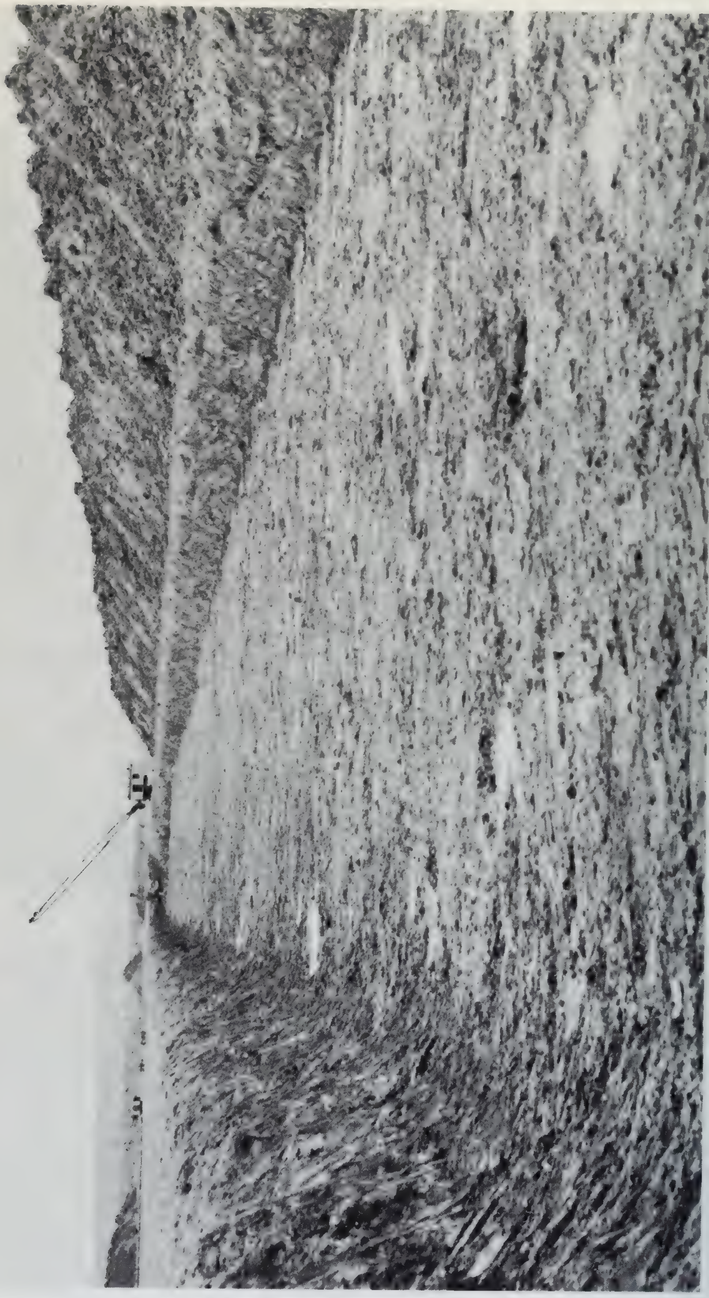

FIGURE 44. Stripping overburden from crystal salt at the California Salt Company operations on Bristol Lake. Floor of the cut leading to the dragline is the upper surface of the salt bed which will be mined.

Tertiary lake bed series which probably extends northwestward into the Owl Springs area.

California Salt Company (California Rock Salt Company, Consumers Salt Company). Location: secs. 11-15, 20, 22-24, 27-29, and 32-35 inclusive, T. 5 N., R. 12 E., S.B.M. Ownership: The California Salt Company, W. F. Biedebach, president, 2436 Hunter Street, Los Angeles, California, owns 35 placer claims, one of which is patented.

The claims now owned by the California Salt Company were originally located in 1908 for calcium chloride. From 1910 to 1918, the property was operated for the recovery of calcium chloride and nearly all the sodium chloride was discarded. Even after 1918, when the Consumers Salt Company held the property and produced some salt,[219] calcium chloride continued to be of greater importance. Only a few thousand tons of salt was produced between 1910 and 1920.

During the 1920's, the claims were leased by the California Rock Salt Company which subsequently became the California Salt Company; the latter purchased the claims from the Consumers Salt Company in 1927.[220]

The combined operations on this property from 1912 to 1951 inclusive have produced 1,609,091 tons of salt; during the same period 133,091 tons of calcium chloride was produced.[221] These amounts represent over 98 percent of the salt produced during the same period by all operations on Bristol Lake and about 48 percent of the total calcium chloride production.

The geology of the saline deposits of Bristol Lake has been discussed by Gale [222] and summarized above. A physiographic description of the area has been given by Thompson.[223]

The salt deposit being mined is the uppermost in a series of beds of rock salt intercalated with fine sediments. In 1951 a drill hole was started in the center of sec. 34, T. 5 N., R. 12 E. as a joint project of the California Salt Company and the National Chloride Company. Early in 1952 this hole was completed to a depth of 1005 feet. Cores were recovered to a depth of 955 feet and showed that the salt-sediment series extends at least to that depth.

Saline mud overlies the uppermost salt bed and both range in thickness from about 3 to 7 feet. A significant proportion of mud is also distributed irregularly through the salt bed.

The overburden is stripped from the salt bed along a series of trenches. The exposed salt is then drilled with an auger bit and blasted with dynamite. The broken salt is loaded by dragline onto 5-yard, side-dump cars which are hauled, 20 cars in a train, by a gasoline locomotive about 4 miles to the washing plant in the NE.$\frac{1}{4}$ of sec. 11, near Saltus.

At the plant, the salt is crushed to minus-$\frac{3}{4}$-inch size and washed in several inclined spiral conveyors. The wash water, obtained from several brine wells near the plant ranging in depth from 160 to 200 feet, flows counter to the conveyed salt and removes clay and other impurities. The washed salt is discharged to storage bins for shipment by rail or truck.

[219] Cloudman, H. C., op. cit., p. 893, 1919.
[220] Biedebach, W. F., personal communication, 1951.
[221] Biedebach, W. F., personal communication, 1952.
[222] Gale, H. S., Geology of the saline deposits Bristol Dry Lake, San Bernardino County, California: California Div. of Mines Special Rept. 13, 21 pp., 1951.
[223] Thompson, D. G., The Mohave Desert region, California: U. S. Geol. Survey Water-Supply Paper 578, pp. 689-704, 1929.

FIGURE 45. Aerial view of West End Chemical Company plant from the west. Searles Lake at top. Part of village at lower right. *Photo courtesy West End Chemical Company.*

The output capacity of the plant is 50 tons per hour. Nearly 50 percent of the incoming material is rejected as waste.

Calcium chloride brine is also recovered by the company from either shallow wells, averaging 30 feet in depth, or from trenches which are deeper than those for salt recovery. The brine is concentrated by solar evaporation, and sold as a liquid. The company employs 35 men in the mining operations and at the plant.

Sodium Carbonate

The sodium carbonate produced in San Bernardino County is obtained from two plants which treat Searles Lake brine; one, operated by the West End Chemical Company, is described below; the other, operated by the American Potash and Chemical Corporation, is described in the potash section of this report.

West End.[224] Location: secs. 24, 25, 26, 27, 31, 33, 34, 35, 36, T. 25 S., R. 43 E., secs. 30, 31, T. 25 S., R. 44 E., and secs. 5, 6, T. 26 S., R. 44 E., M.D.M. Ownership: West End Chemical Company, 608 Latham Square Building, Oakland, California, owns in fee 720 acres on the southwest shore of the lake and has 2900 acres, in the central part of the lake, under federal lease.

The West End Chemical Company, organized in 1920 by F. M. "Borax" Smith, at first sought to recover borax and potash from Searles Lake brine. A plant was constructed on the southwest edge of the lake; but, as the process proved unsuccessful, the plant was shut down soon after its completion. In the period 1923-1926 the plant was redesigned to recover soda ash and borax. The resulting process, the one still in use today, involves 1) a carbonation of the brine with carbon dioxide gas to form sodium bicarbonate, 2) a calcining of the bicarbonate to soda ash and carbon dioxide, 3) a mixing of the brine, after carbonation, with crude brine from the lake, and 4) the precipitation of borax by cooling, seeding, and agitating the mixed brine. In the successful operation of this process, the West End Chemical Company became the principal producer of soda ash in California.

Brine is pumped from both the upper and lower salt bodies,[225] at levels of 65 to 115 feet. It is distributed to 72 carbonating towers each 5 feet in inside diameter, 75 feet high, and of wood stave construction. The brine is introduced at the top of the towers and CO_2 is bubbled through it, the absorption facilitated by baffles. According to the reaction,

$$Na_2CO_3 + H_2O = 2NaHCO_3,$$

the carbonates in the brine are converted to sodium bicarbonate which is precipitated and removed as sludge. A small crop of additional bicarbonate is obtained from brine emitted from the carbonation towers by sending the brine through a series of agitating tanks and thickeners. The bicarbonate from both sources is allowed to settle in classifiers, then filtered and washed at the rate of about 850 tons per day. It is next dried and fed into furnaces where it is calcined to fluffy, light brown soda ash.

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224 The data in this section were drawn largely from the following reference: Wiseman, J. V., and Blackmun, L. A., Recovery of alkaline salts from Searles Lake by the West End process: unpublished paper presented before A.I.M.E., Southern California section meeting, Los Angeles, Oct. 25, 1951.

225 See description of Searles Lake in this report.

To bleach the ash and increase its density it is treated with a very small proportion of sodium nitrate and reheated in a rotary furnace. From here it is carried to an air separator where it is divided into coarse and fine fractions.

At this stage both fractions contain about 1½ percent borax which was originally precipitated in the carbonation towers. Glass manufacturers, the principal consumers of the coarse soda ash, find the borax content to be desirable. For other uses the finer-grained fraction is refined, generally to 99.5 percent Na_2CO_3 or better. The refining involves recrystallization as sodium carbonate monohydrate, filtering, washing, and calcining.

In the first step of borax recovery, lake brine is added to brine from which sodium bicarbonate has been removed. An optimum pH for the conversion of borates to the tetraborate is thus obtained. The brine is cooled to supersaturation, at a temperature slightly below 60° F., in a series of heat exchangers. It is then transferred to agitators and seeded with borax crystals. The borax precipitate is settled in a hydro-separator, thence passed through classifiers, thickeners, and density controllers, and is finally filtered on a salt type Oliver Filter.

Refined borax is prepared by dissolving the crude material in hot end liquors. The hot solution is filtered and the filtrate cooled to recrystallize the borax which is in turn centrifuged, dried, passed over a magnetic separator, and screened to produce a granular borax and a powdered borax.

Anhydrous borax is produced by first drying crude borax in a rotary drier, then fusing it in a specially designed furnace. The fused borax is rolled into sheets, crushed, ground, screened, and passed through a magnetic separator, and an air separator.

Carbon dioxide for the plant is prepared by burning limestone obtained at the northern end of Searles Valley. Coke for this process is shipped from Alabama. The quick lime thus obtained is hydrated and sold as chemical lime.

Brackish water for general use in the plant is obtained from nearby wells. Fresh water is piped 20 miles from Indian Wells Valley.

Sodium Sulfate

Sodium sulfate is recovered from the upper structure brine of Searles Lake by the American Potash and Chemical Corporation and rates as high as 600 tons per day. This is the only current source of sodium sulfate in California.

The occurrence of sodium sulfate in the Old Dad Mountains and in the Dry Lake district, 60 miles east of Victorville, has been noted,[226] but neither of these prospects has been exploited. Noted in the tabulated property list at the end of this report is a reported recovery of sodium sulfate from the surface of Danby Dry Lake.

Sodium sulfate was the principal mineral commodity produced at the plant of the Dale Chemical Industries, Incorporated, on Dale Dry Lake. This plant, idle since December 1948, is described below.

Dale Chemical Industries, Incorporated (Chemical Mines Company, Dale Lake Sodium Sulfate Deposit, Desert Chemical Company). Location: secs. 23, 26, 27, 34, and 35, T. 1 N., R. 12 E., S.B.M., on the north

[226] Tucker, W. B., op. cit., p. 322, 1930.

side of Dale Dry Lake about 20 miles east of Twentynine Palms. Ownership: Dale Chemical Industries, Incorporated, Twentynine Palms, California, or 61 Broadway, New York, New York, owns 40 placer claims totalling 1840 acres.

The first exploration work on this deposit was done between 1920 and 1924 by Irving E. Bush who drilled a number of test holes. Since that time, several attempts have been made to work the deposit. In 1939 the property was leased to the Desert Chemical Company which subsequently purchased the property. In 1947 the property was purchased by the present owners, who discontinued operations in December 1948 because of the drop in the price of sodium sulfate.

Dale dry lake contains bedded deposits of thenardite, anhydrous sodium sulfate, some of which crop out on the southwest end of the lake bed. These deposits are briefly described above. Thenardite was mined from this outcrop in the early 1940's by the Desert Chemical Company which also recovered sodium sulfate from the brine permeating the crystal body of the lake. The principal recovery of sodium sulfate, however, has been made from the brine, which contains 22 percent sodium chloride and 7 percent sodium sulfate at a temperature of 70° F.[227] King [228] reports a total salinity of 298 grams per liter, the content of sodium sulfate and sodium chloride being 70 and 220 grams per liter, respectively.

Brine was pumped from 10 wells, each about 250 feet deep, and in which the brine level averaged about 57 feet, to four 7-acre ponds used to precipitate Glauber's salt, hydrous sodium sulfate, by solar evaporation during the summer or by spraying during the winter. During the winter, Glauber's salt was precipitated by spraying concentrated brine into the air when the average temperature was below 45° F. The Glauber's salt recovered from solar evaporation or the spraying process was treated in the plant by melting with steam then adding sodium chloride to "salt out" the anhydrous sodium sulfate or salt cake. The sodium chloride brine remaining after the precipitation of Glauber's salt was either pumped back into the lake or into other evaporating ponds for recovery of salt.

Fresh water for the plant and camp facilities was supplied from 2 wells located 3 miles westward from the camp. When the plant was operating, 85 men were employed.

Strontium

Strontium-bearing minerals in concentrations of proved or possible commercial interest are known to exist at several localities in San Bernardino County; all are in Tertiary or Recent formations. By far the largest are the celestite deposits, about 4 miles northwest of Argos. These occur as beds in a thick Tertiary series of tuff and shale. Celestite beds and concretions are associated with gypsum and gypsiferous clay in the eastern part of the Avawatz saline-bearing belt described in the gypsum section of this report. Celestite concretions are present in Recent sandy gypsiferous clay along the south edge of Bristol Dry Lake, and in Tertiary gypsiferous clay near Owl Hole Spring. Strontianite beds and concretions exist in Tertiary shaly tuffs and clays about 10 miles north of Barstow.

[227] Tucker, W. B., and Sampson, R. J., op. cit., p. 540, 1943.
[228] King, Clarence R., Soda ash and saltcake in California: California Jour. Mines and Geol., vol. 44, p. 190, 1948.

Small tonnages were removed from the Argos and Barstow deposits during the period 1916-1918. These deposits were reopened during World War II when the imports of strontium-bearing minerals were curtailed and the demand was high. During World War II the largest output was obtained by the Rowe-Buehler Mining Company with holdings on part of the Argos zone. A smaller output was obtained by the DuPont Company from their property on the same zone. The operation of the Barstow deposits, undertaken by the Strontium Carbonate Mines, was also on a small scale. An unsuccessful attempt was made during World War II to recover celestite from Bristol Dry Lake.

The Tertiary tuffaceous and shaly unit, containing the Argos celestite deposits, lies in a west- to northwest-trending belt along the southern front of the Cady Mountains.[229] The celestite-bearing zone, largely hidden beneath dune sand, is discontinuously exposed for a lateral distance of about 4000 feet and dips from 20° to 50° southward. Celestite occurs as beds as much as 5½ feet thick distributed through a stratigraphic thickness of at least 250 feet. Most of the celestite, however, is in beds less than a foot thick.

The celestite rock is very fine-grained. Selected samples of the rock are reported by Moore [230] to have contained from 70 to 93 percent celestite. Durrell [231] has estimated that the deposits contain at least 1,140,000 tons of celestite per 50 feet of depth.

The general features of the other occurrences of strontium minerals are noted briefly in the tabulated list at the end of this report.

Miscellaneous

Under a miscellaneous classification have been placed the Victorite pyrophyllite, and the Marter-White deposits, described below, as well as two garnet deposits noted in the tabulated list.

Marter-White (Velvet White) Deposit. Location: secs. 27 and 34, T. 7 N., R. 4 W., S.B.M., 3½ miles east of Bryman, a siding on the Santa Fe railroad. Ownership: The original 160-acre placer claim (Velvet White) is owned by Mrs. Beryll Driscoll and Mrs. Dorothy L. Gordon, Los Angeles, California, and is leased to Marter Mining Company, 530 West 6th Street, Los Angeles, California. The company holds 640 acres in claims adjoining the Velvet-White.

The material known commercially as Marter-White occurs in hydrothermal alteration zones in volcanic rocks of the Sidewinder series. The zones exist in a belt, nearly 3 miles long and as much as 1000 feet wide, along the west flank of Silver Mountain. Here the Sidewinder series, Mesozoic in age, consists largely of andesite. Within the belt there are marked differences in the degree of alteration and deposits of known commercial interest occur only locally. The alteration has been guided by fractures and appears to have been somewhat selective.

The product mined at the Marter-White quarries is unusually white and fine-grained. Without grinding and when broken down in water, 90 percent will pass 325 mesh and 75 percent minus 10 microns. The rock probably consists mostly of sericite and quartz. It is used as a filler

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229 Moore, B. N., Some strontium deposits of southeastern California and western Arizona: Am. Inst. Min. Met. Eng. Trans., vol. 115, pp. 357-362, 1935.

230 Moore, B. N., op. cit., p. 371, 1935.

231 Durrell, Cordell, Strontium deposits of Southern California (abst.): Geol. Soc. America Bull., vol. 58, p. 1250, 1947.

FIGURE 46. Open cut on Marter-white deposit. Material is alteration of Sidewinder volcanic rocks exposed in background. *Photo courtesy Marter Mining Company.*

and extender in paint, rubber, phonograph records, plastics, insecticides, and other fields.

The material is mined with bulldozers and skip loaders, crushed, and trucked to Los Angeles for sale. The main pit is driven easterly into Silver Mountain and has a face about 30 feet high. The pit is about 100 feet long on a north-south direction, and 80 feet wide. Several other smaller pits are nearby.

About 4000 to 5000 tons per year are mined, and the operators report that surface stripping and test holes have blocked out over 1,000,000 tons of high grade filler.

Victorite Pyrophyllite Deposit. Location: secs. 24, 25, T. 7 N., R. 3 W., S.B.M., about two airline miles southwest of Stoddard Mountain, and about 12 airline miles northeast of Victorville. Ownership: Mineral Materials Company, 1145 Westminster Avenue, Alhambra, California; Mr. Claire W. Dunton, manager, owns five claims in sec. 24 and is purchasing 640 acres in sec. 25 from the Southern California Minerals Company of Los Angeles.

The Victorite property is a prospect which the operators intend to develop as a source of mineral filler. Intermittent shipments of undetermined tonnage were made during 1950 and 1951. It has been used experimentally by ceramic plants, and by a battery manufacturer for battery case filler.

The deposit is a hydrothermally altered zone in volcanic rocks of the Sidewinder series. Work to date has centered about an elongate lens that strikes northwest and seems to dip steeply southwest. Though not well exposed, it is at least 30 feet wide, about 125 feet in exposed length, and

may be much longer. The northern extension of the deposit is hidden beneath alluvium. The volcanic rocks, principally andesite and dacite, border the alteration zone. To the southeast, other irregular-shaped patches of altered material have been exposed by bulldozer cuts. These bodies, however, appear to be smaller than the main one.

The altered material is foliated and is composed mostly of pyrophyllite, but contains probably also quartz. Streaks and lenticular-shaped bodies, as much as one-half-inch wide, of unaltered or semi-altered rock are common at the edges of the zone.

Development consists of an open cut driven southward into the hill and along the strike of the main body. The cut is 30 feet wide and 20 feet long, with a 15-foot face. About 300 feet to the southeast, another, shallower cut, 30 feet wide has been driven for a short distance on another body.

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TABULATED LIST OF MINES AND MINERAL DEPOSITS IN SAN BERNARDINO COUNTY

The data contained in the following tabulated list was drawn from investigations by the writers as well as from other sources, both published and unpublished, believed by the writers to be authentic, but commonly not verified by them.

The list, like the foregoing section, is divided into three sections: metals, nonmetals, and salines. The number in the first column is the number given the location of the deposit if it appears on the map, plate 1. Synonyms are given in parentheses after the preferred name and appear as cross-references elsewhere in the list.

The ownership, unless otherwise indicated, was that at the time of writing. Uncertain section locations are followed by a question mark. The abbreviation ''approx.'' indicates an approximate township location; ''proj.'' indicates incomplete public land survey lines on the base map.

References appear in parentheses in the last column and refer to the accompanying bibliography. Only the last name of the senior author is given. The first number after each name is the year of his first publication, and is separated from the page reference by a colon. Succeeding references are preceded by semicolons. The term ''herein'' refers the reader to a description in the body of the text.

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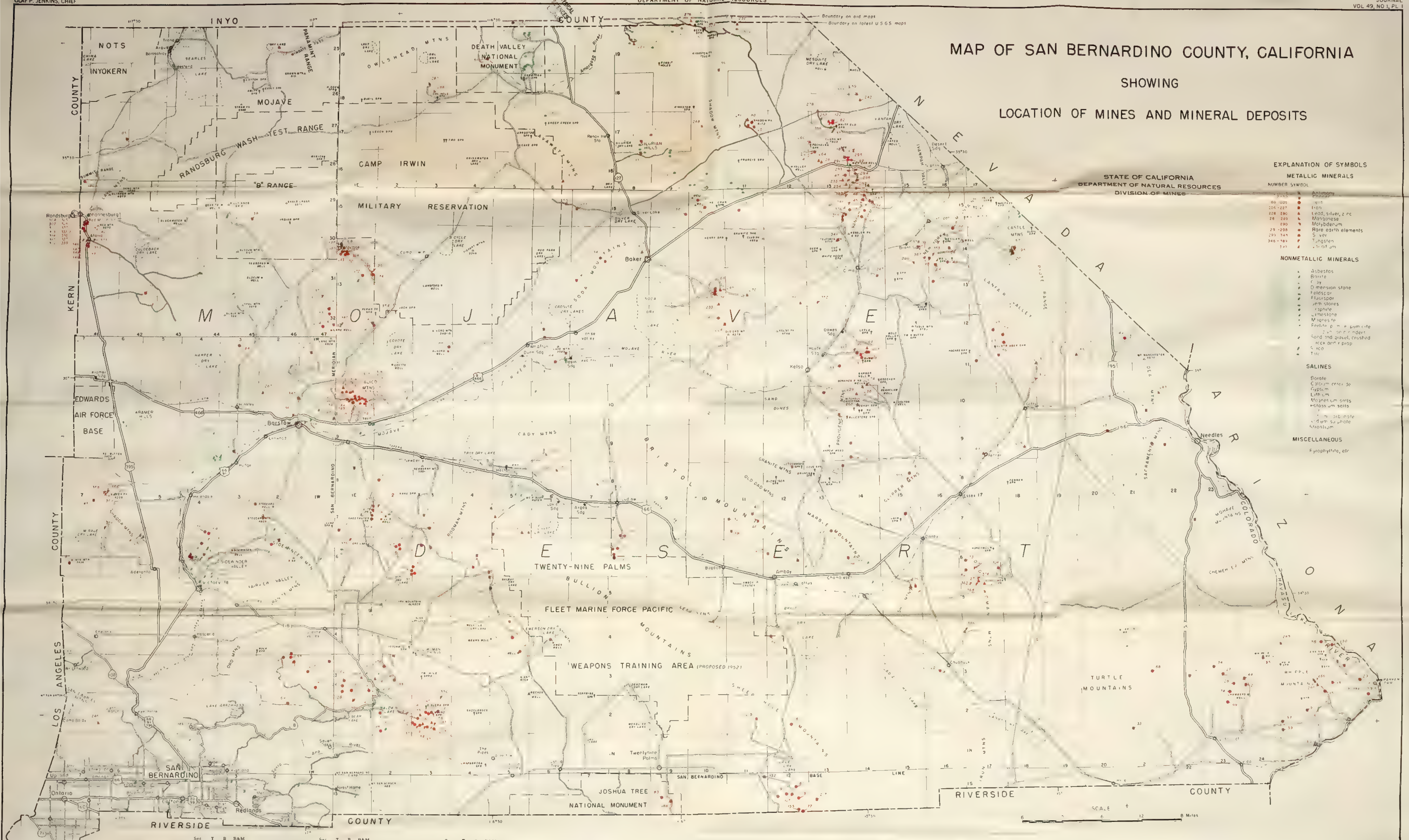
VOL 49, NO 1, PL 1



METALLIC MINERALS

No.	Name	Sec	T	R	B&M
	ANTIMONY				
1	Desert Antimony	18	16N	14E	S B
	COPPER				
2	Allored Erisman	21 22	15N	14E	S B
3	Amazon	15	6N	4W	S B
4	Azurite Blue Bonnet	22,27	32S	47E	M D
5	B and B Jackass	4,5 8,9	11N	1W	S B
6	Black Metal	23	3N	26E	S B
7	Black Mountain	16	10N	21E	S B
8	Black Mountain	19 20	6N	7W	S B
9	Blue Cloud	26	2N	25E	S B *
10	Blue Ribbon Placer	3,4	4N	8E	S B
11	Bumper group	30	7N	23E	S B
12	Claw Hammer group	9,10	8N	1E	S B
13	Copper Basin	4	2N	26E	S B
14	Copper Commander	6	16N	13E	S B
15	Copper Gulch (Big Butte Copper Butte)	28	9N	22E	S B
16	Copper King	25	16N	13E	S B
17	Copper Queen	26	3N	22E	S B
18	Copper Queen	30	14N	16E	S B
19	Copper Strand Haney and Lee Independence	9	6N	3E	S B
20	Copper World Dewey, Ivanpah Ivanpah Copper Old Ivanpah Copper Co	6	16N	13E	S B
21	D. and W. Dayton and Wilbur	32	[illegible]	[illegible]	[illegible]
		5	8N	26E	S.B
22	Desert Butte group	16	3N	16E	S B
23	Francis	9	11N	14E	S B
24	Giant Ledge	31 32	14N	16E	S B
25	Glory Foster	14 15	17N	11E	S B *
26	Gold Banner	12 13	7N	1E	S B
27	Gold Hill Copper	27	3N	23E	S B *
28	Gold Standard	36	3N	23E	S B *
		1	8N	23E	S B *
29	Gold Trails	31	3N	27E	S B
30	Greenback	12	7N	1E	S B
31	Grey Copper	15 16	17N	11E	S B *
32	Hercules	18	7N	11E	S B
33	Horn	32 ?	2N	21E	S B *
		5 ?	1N	21E	S B *
34	Indicator	31	3N	23E	S B *
35	Iron Cap	35	19N	10E	S B *
36	Ivanpah Mammoth	14	15N	14E	S B
37–49	[illegible]				
50	Standard No 2	19,30	16N	14E	S B
		24,25	16N	13E	S B
51	Surprise	28	9N	3W	S B
52	Tip Top	31	7N	6E	S B
		36	7N	4E	S B
53	Trade Rat	9 16	32S	47E	M D
54	Trio	21,23	14N	16E	S B
55	Virginia Copper War Eagle Copper Old Roth	10,15	3N	24E	S B *
56	Von Trigger California Gold and Copper Co Dutch Oven Runover Consolidated Von Trigor	2,10,11 16	11N	17E	S B
57	Vulture Emperor	31	17N	13E	S B
58	Winifred group	29,30	7N	11E	S B
59	Wyatt Earp Happy Day, Roosevelt	6	1N	25E	S B *
	GOLD				
60	Alvord	1,2,12	11N	3E	S B
61	Amargosa Gold Placers Sharpe Diggings	11 14,23			
		21,25	19N	4E	S B
62	America (American	18 19	4N	12E	S B
63	American Flag	35,36	12N	17E	S B
64	Apex	35	7N	4W	S B
65	Arrastre	9	32S	47E	M D
66	Arrowhead Probably same as Gold Pin	16	15N	10E	S B
67	Azucar	19	8N	2E	S B
68	Bagdad Chase Bagdad, Camp Rochester Chase, Pacific Mines, Roosevelt Consolidated	7,8	6N	8E	S B
69	Balanced Rock	11	3N	2W	S B
70	Belmont	29	14N	1E	S B
71	Big Horn Contention Investment Mabel, Mable	20	9N	[illegible]	S B
72	Black Hawk	7	30S	41E	M D
73	Blue Eagle Florence	19,20	6N	17E	S B
74	Bluff and Western	11	2N	23E	S B *
75	Branch	27	7N	4W	S B
76	Brannigan	26,27	12N	10E	S B
77	Brooklyn	36	1S	12E	S B *
78	Bullion Range	7	6N	8E	
79	Camp Rock Placer Clark Diggings	28	7N	3E	S B
80	Carlyle Carlisle	11 14	1S	12E	S B *
81	Coarse Gold	32	9N	14E	S B
82	Colosseum	10,14	17N	13E	S B
83	Contact	20	1S	9E	S B
84	Coolgardie Placer	2,3,4	11N	3W	S B
85	Crystal	23	4N	6E	S B
86	Cumberland (High Hope	35	6N	2E	S B
		30	6N	3E	S B
87	Daisy	24	12N	1E	S B
88	Dan Hentie	10,15	17N	11E	S B *
89	Darling	2	14N	16E	S B
		35	15N	16E	S B
90	David-Mill King	36	4N	2W	S B
91–110	[illegible]				
111	Gold Point (Henshaw Murray	1	3N	1W	S.B
112	Gold Reef Consolidation for operating purposes during 1917 18 of the Copper Mountains, Gold Reef and Tom Reed mines	14,15	7N	15E	S B
113	Gold Ridge Ibex	13,24	9N	20E	S B
114	Gold Standard	32	7N	8E	S B
115	Gold Zone	17	3N	27E	S B
116	Golden Cycle (Camp Castle Castle Great Gold Belt	26	7N	13E	S.B
117	Goldstone	22	1S	12E	S B *
118	Goldstone	19	14N	1E	S B
119	Grandview	10,11	6N	2E	S B
120	Green Gold	19	14N	18E	S B
121	Green Lead	27	3N	1W	S B
122	Greene	10	17N	13E	S B
123	Hafford	14 15 22,23	25S	45E	M D *
124	Harvey K (Hepburn	29	3N	1E	S B
125	Hidden Hills	1	8N	13E	S B
		6	8N	14E	S B
126	Holliday	29	2N	3E	S B
127	Hollie-Ann	29	2N	3E	S B
128	Holcomb Valley placers	29 31 32,33	3N	1E	S B
		4,5 6	2N	1E	S B
129	Hoover	10	6N	2E	S B
130	Islander	4	3N	16E	S.B
131	Ivanhoe Hidden Treasure	23,26	1S	12E	S B *
132	Ivanhoe Mill	1	1S	11E	S B *
133	Jo Je (Midway)	23	11N	13E	S B *
134	John Henry	28	2N	3E	S B
135	Johnson	36	6N	2E	S B
		31	6N	3E	S B
136	Jumbo	25	18N	9E	S B
137	Keystone	18	7N	2W	S B
138	Lester	21	3N	2E	S B *
139	Log Cabin	29 30	3N	3E	S B
140	Long Shot	30 32	6N	17E	S.B
141	Los Padre	25	4N	6E	S B *
142	Lucky	11	11N	10E	S B
143	[illegible]	19,30	14N	1E	S B
144	Markeson	[illegible]	[illegible]	[illegible]	S.B
145	McCrure Bees	16	2N	3E	S B
146	Merrick Gold Crown group	20	14N	1E	S.B
147	Mohawk Cambria Mescal	24	18N	13E	S.B *
148	Morning Star	21,27 28,33	18N	14E	S B
149	Mountain Flat (Golden West	35	12N	20E	S B
150	New Era	20,?	16N	14E	S B
151	Nickel Plate	8	2N	26E	S.B.
152	O K	31	29S	41E	M D
153	O K Storm King Consolidated	35	1S	12E	S B *
154	Old Pete Yim-Wheelock	33	7N	[illegible]	[illegible]
155–172	[illegible]				
173	Rex	10	10N	13E	S B
174	Rio Hondo	12	13N	1E	S B
175	Rose (Includes Christie workings	19,20	2N	3E	S B
176	Roulette	6	3N	26E	S B *
		31	4N	26E	S B *
177	St Elmo	29 30	30S	41E	M D
178	Santa Fe Includes workings known variously as Arlington Black Hawk Casa de Oro Calumet, Cliff Hecla Lady Alice, Lookout and Opera	5,8 9,16 17	3N	2E	S B
179	Scanlo (Hercules	26 ?	12N	17E	S B
180	Sheep Hole	27	2N	12E	S B *
181	Sidewinder	4,5	6N	2W	S B
182	Silver Basin Elkhorn Mining Co Golden Era	7	30S	41E	M D
183	Sky Blue No 3	19	14N	1E	S B
184	Smith	15	11N	6E	S B *
185	Spangler	36	27S	41E	M D
186	Star	8,9	11N	14E	S B
187	Stewart Jackass	16	2N	3E	S B
188	Sullivan No 1 Anaconda	22,27	1S	9E	S B
189	Sulphide Queen	12,13	16N	13E	S B
190	Summit Diggings	1 12	29S	40E	M D
191	Supply Jean, the Nightingale and Supply mines were operated by the Gold Crown Mining Co and sometimes referred to as the Gold Crown	21,22 27,28	1S	12E	S B *
192	Telegraph	16 17 20	15N	11E	S B
193	True Blue Gold Basin	22 ?	12N	17E	S.B
194	Uncle Sam	20,21 28,29	14N	1E	S B.
195	Valley View	19	14N	18E	S B
196	Vanderbilt Boomerang, Brick Consolidated, Gold Bar, Webster				
197	Vaughn placer	16	2N	3E	S B
198	Victor Big Four Red Bridge	22 18,19	30S 14N	47E 1E	M D S B
199	Vidal Gold Dollar Bill, Savahal	14 15	2N	23E	S.B *
200	Virginia Dale	20	1S	12E	S B *
201	Vulcan McClintock	11	5N	15E	S B
202	Wanderer Wonderer	8	15N	10E	S B
203	Weaver Diggings	34	2N	3E	S B
204	Williams Well placers	19,20 29 30	32S	47E	M D
205	Wright	16,17	3N	1W	S B
	IRON				
206	Altuda (Globerson	1	7N	3W	S B
207	Amboy Iron	18	6N	12E	S B
208	Ball	3,4	6N	2W	S B
209	Beck Iron Gossam, Kingston Mountains, Kingston Range	32 33	20N	10E	S B *
210	Bessemer	27,28	6N	4E	S B
211	Bessemer Iron Mine No 1	36	6N	4E	S B
212	Black Jack	24	6N	12E	S B
213	Cave Canyon	11,12	11N	6E	S.B
214	Cave Mountain Arrowhead Lode Metz	20	12N	6E	S B
215	Copper World	23	2N	11E	S B *
216	Ebony	15	6N	4E	S B
217	Iron Age	20,29	1S	13E	S B *
218	Iron Hat (Armstrong & Doran, Ironclad	17,18 19,20,21	6N	14E	S B
219	Iron King (Silver Lake	18,19	15N	7E	S B
220	Iron Mountain (Silver Lake)	11,12, 13 14	15N	6E	S B
221	Iron Victory	2	8N	12E	S B
222	Morris Lode Ancho, Expansion Hondo, Rincon, Van Buren group	12 7	5N 5N	4E 5E	S B S.B
223	New Bessemer (Alarm	1	5N	4E	S.B
224	Old Dad Mountain (Real Riel	13 or 14	12N	10E	S.B.
225	Ship Mountain Paul)	11,12	5N	16E	S B
226	Vulcan	26,36	10N	13E	S B
227	Undetermined	32 33	13N	6E	S B
	LEAD-SILVER ZINC				
228	Age	23,24 25,26	14N	8E	S B
229	Alexander	9 10	19N	8E	S B *
230	Anaco Red Raven, Red Rover	30,31	7N	6W	S B
231	Avawatz Crown	26	16N	6E	S B *
232	Beck	31	20N	11E	S B *
233	Big Horn	35	13N	10E	S B
234	Blue Bell Hard Luck	27 ?	14N	7E	S B
235	Blue Buzzard	25 or 36	16N	13E	S B *
236	Bonanza King	3	10N	14E	S B
237	Bullion	10 15	16N	14E	S B
238	Burcham (Total Wreck	15,16, 21	10N	1E	S B
239	C and K (Bell Gilroy, Belle McGilroy Lead Capping McGilroy)	9	10N	14E	S B
240	Cactus Flat Morongo)	19	3N	2E	S B
241	Carbonate	17	6N	4W	S B
242	Carbonate King	5	17N	14E	S B
		31	18N	14E	S B
243	Carbonate King Zinc Crystal Cave	4 32	16N 15½N	14E 14E	S B S B
244	Columbia Macedonia)	3	11N	14E	S B
245	Comet	24	13N	10E	S.B
246	Cocamongo Zinc (Blew Jordam	25	2N	7W	S B
247	Death Valley	11	13N	14E	S B
248	Eastern Star	17	17N	10E	S B
249	Fenner Smelting Co	34	9N	17E	S B
250	Gemco	10	6N	17E	S B
251	Gold Hill	10	17N	11E	S B
252	Ibex Arctupus, Arcturus)		20N	6E	S B *
253	Imperial Lode (Cave Springs and Mining Corp	25,36 31	7N 7N	5E 6E	S B S.B
254	Iron Horse	35 or 36 ?	6N	13E	S B *
255	J. Juneau	10	11N	19E	S B
256	Jackpot	35	13N	12E	S.B
257	Jackson (Stonewall, Stonewall Jackson	9	17N	13E	S.B
258	Jeff Davis Sunnyside Lode)	22	2N	3E	S B
259	Kaly	31,32	18N	14E	S B
260	Keiper Bank Rod Green Gold, Kieper, Valentine	In unsurveyed area between 25 and 30	17N 17N	12E 13E	S B S B
261	Lead Mountain	36	10N	1W	S B
262	Lost Spanish	28	2N	3E	S B
263	Mitchell	21	10N	14E	S B
264	Mohawk	7,8 17,18	16N	13E	S B *
265	Mowry Gladstone, Halberg)	35	7N	5E	S B
266	Nigger Mountain (Fremont, Mohawk Zinc	22,23 27	3N	1E	S B
267	Pedry	6,7 18	10N	2W	S B
268	Piute	26	9N	18E	S.B
269	Providence	10	11N	14E	S B
270	Rainy Day	27	15N	11E	S B
271	Scotty Wilson	4	2N	1E	S B
272	Silver Bell	12	7N	4E	S B
273	Silver Dream Tiptop	17	2N	3E	S.B *
274	Silver King (Perseverence	34	11N	14E	S B
275	Silver Reef Silver Cliff	16	7N	6E	S B
276	Silver Rule Chambers)	19	20N	10E	S B *
277	Silver Wave	4	5N	17E	S B
278	Spar King	31,32	17½N	13E	S B
279	War Eagle	2 3	4N	10E	S B
280	Yucca Yucca Queen	8,17	18N	13E	S.B *
	MANGANESE				
281	Big Reef (Black Butte, Mott and Pisgah	10	8N	6E	S B
282	Black Magic Emmel	5,8	18N	3E	S B *
283	Black Mountain (Gallagher	17,20	10N	22E	S B
284	Lee Yim (Garinger Lavic Mountain, Manganese 1-10, Root	22,23	8N	7E	S.B
285	Logan (Trans-Oceanic, Treasure	28 32	9N	6E	S.B
286	Monument King (Cross Roads Hidden Cross, Hidden Treasure, Manganese King	1 36	2N 3N	25E 26E	S B * S B
287	Mouton Mine Juleff Red Cross)	6	2N	26E	S B
288	New Deal (Old Hole, Owls Head Owls Hole	16	18N	3E	S B
289	Stewart	6	3N	26E	S B
	MOLYBDENUM				
290	Big Hunch	35	14N	15E	S B
	RARE EARTH ELEMENTS				
291	Birthday? group	12 13	16N	13E	S B *
292	Horseshoe group	30	16N	14E	S B
293	Lucky Strike group	24 ?	16N	13E	S B *
294	Mineral Hill Claims	19	16N	14E	S.B
		30	15½N	14E	S B
295	Mountain Pass	12,13	16N	13E	S B
296	Rathburn group	31	16N	14E	S B
297	Summit group	21 30, 31,32	15½N	14E	S B
298	Windy Boy group	29	15½N	14E	S.B
	SILVER				
299	Akron-Silver Reef	3 4	3N	2E	S B
		33,34	4N	2E	S B
300	Alabama-Mountain View Snowbird group	14,15	10N	1E	S B.
301	Alta	24	17N	8E	S.B *
		19	17N	9E	S.B
302	Annex Silver Hills)	26	17N	8E	S.B *
303	Argentum group	10,15	10N	1E	S B
304	Belcher extension	7	30S	41E	M D.
305	Bismarck	10,15	10N	1E	S B.
306	Blackfoot Blackfoot-Goiconda)	13,14	10N	1E	S.B.
307	Bray and Bisbee	6	30S	41E	M D
(238	Burcham (Total Wreck				
308	Carbonate	23	10N	1E	S B
309	Consolidated, Consolidated Extension	15	10N	1E	S.B.
310	Coyote	6	30S	41E	M D.
311	Dietzman group	23	10N	1E	S.B
312	Falls Sioux Sue	13	10N	1E	S B
313	Flat Tire	6	30S	41E	M D
314	Fox Lease	6	30S	41E	M D
315	Galena King Revier	6	10N	1E	S B
316	Garfield (Garfield-Thunderer	14,15	10N	1E	S B
317	Garford Lease	7	30S	41E	M D
318	Humbug	10	10N	1E	S B
319	Kelly (Calif Rand	6	30S	41E	M D
320	Lamar	15,17	10N	1E	S B
321	Langtry	7,8	10N	1E	S.B
322	Leviathon	8,9	10N	1E	S B
323	Lone Star (Lode Star	15	10N	1E	S.B
324	Lucky Jim	30	6N	16E	S B
		25	6N	17E	S B
325	Mizpah Montana	6	30S	41E	M D
326	Navajo and Swastika Grady No 1 & 2	7	30S	41E	M D
327	Occidental	10,15	10N	1E	S B
328	Odessa	14	10N	1E	S B
329	Oriental	15	10N	1E	S B
330	Possibility Prosperity	17	10N	1E	S B
331	Riggs	2	16N	8E	S B
332	Santa Fe (Wortley Consolidated Mines Co)	6	30S	41E	M D.
333	Silver Bell (Silver Belle	6	30S	41E	M D
334	Silver Bow	9	10N	1E	S B
335	Silver Contact	9	10N	1E	S.B
336	Silver Glance	6	30S	41E	M D
337	Silver King (Johannesburg Mining & Milling Co	6	30S	41E	M D.
338	Silver King (Silver King Oriental)	15,22	10N	1E	S.B.
339	Silver Moon	6	30S	41E	M D.
340	Silver Monument	22	10N	1E	S.B.
341	Teutonia	11	14N	13E	S.B.
342	Union	16	10N	1E	S.B.
343	Voca	16	10N	1E	S.B.
344	Waterloo	16,21	10N	1E	S.B.
345	Waterman	18	10N	1W	S.B
		13	10N	2W	S.B.

TUNGSTEN
[illegible]

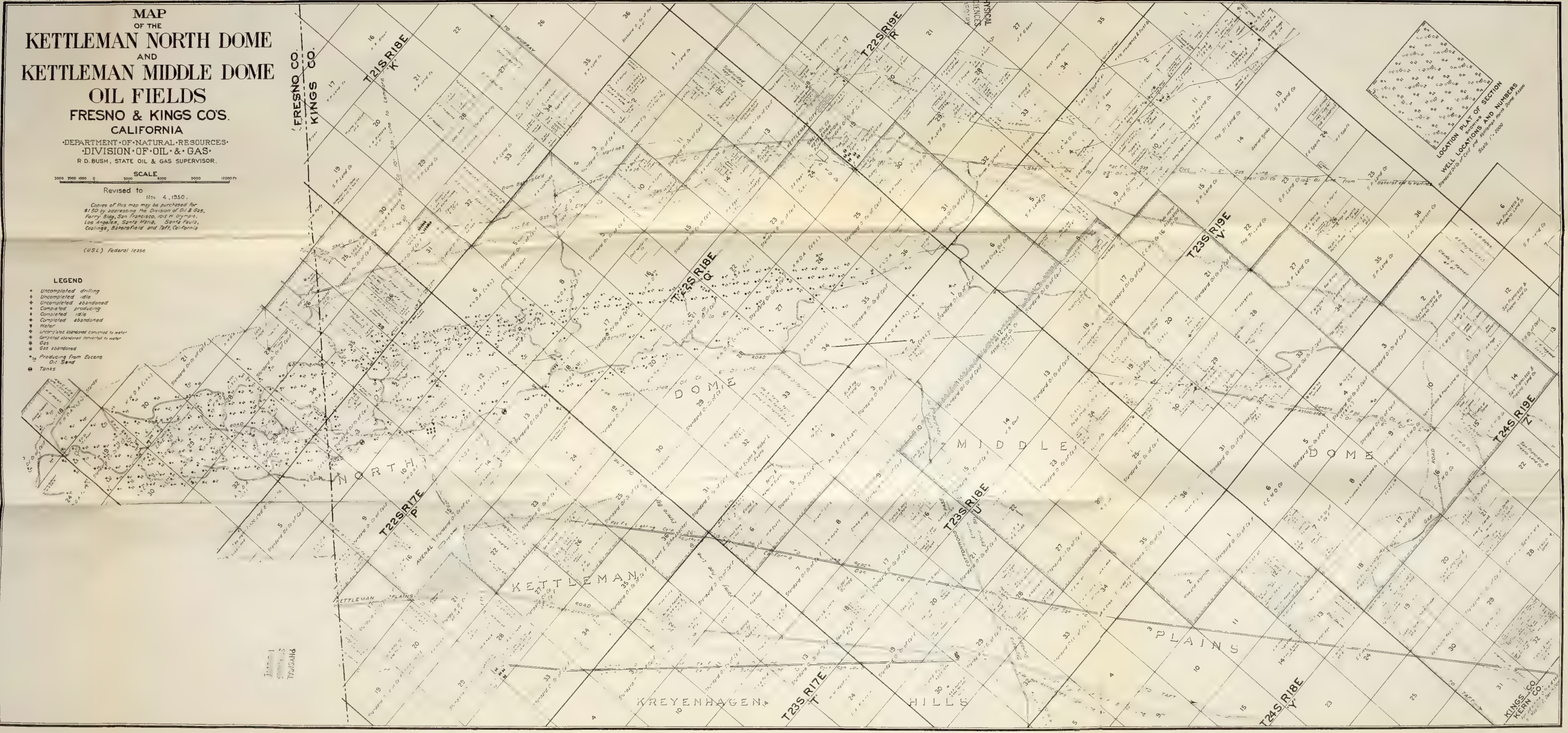
VANADIUM
[illegible]

NONMETALLIC MINERALS
ASBESTOS
[illegible]
BARITE
[illegible]
CLAY
[illegible]
DIMENSION STONE
[illegible]
FELDSPAR
[illegible]
FLUORSPAR
[illegible]
GEM STONES
[illegible]
GRAPHITE
[illegible]
LIMESTONE
[illegible]
MAGNESITE
[illegible]
PERLITE PUMICE PUMICITE AND VOLCANIC CINDERS
[illegible]
SAND AND GRAVEL CRUSHED ROCK AND RIPRAP
[illegible]
SILICA
[illegible]
TALC
[illegible]

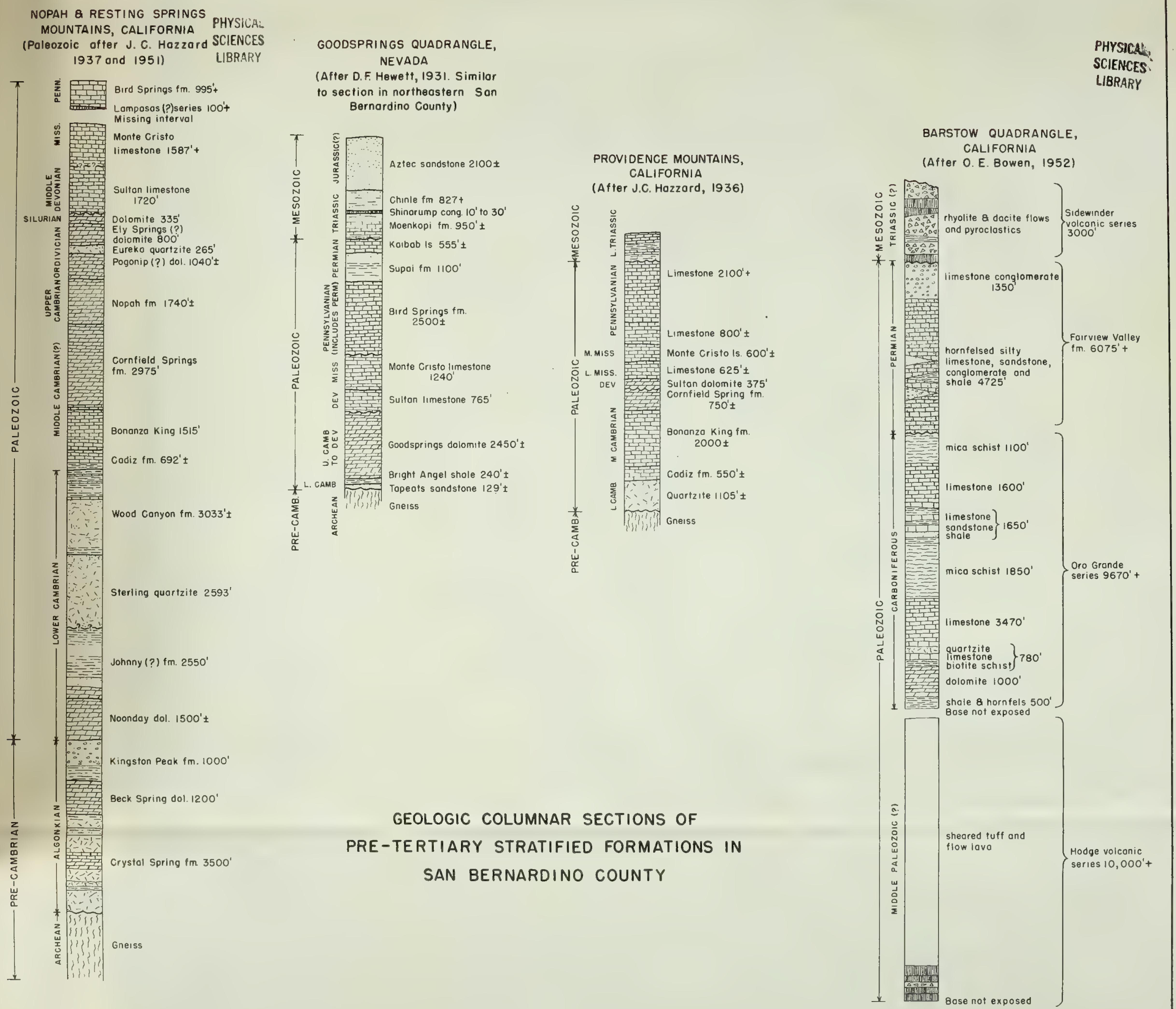
SALINES
BORATE
[illegible]
CALCIUM CHLORIDE
[illegible]
GYPSUM
[illegible]
LITHIUM
[illegible]
MAGNESIUM SALTS
[illegible]
POTASSIUM SALTS
[illegible]
SALT
[illegible]
SODIUM CARBONATE
[illegible]
SODIUM SULPHATE
[illegible]
STRONTIUM
[illegible]

MISCELLANEOUS
[illegible]

*Location of mines marked with an asterisk is projected



MAP OF THE
KETTLEMAN NORTH DOME
AND
KETTLEMAN MIDDLE DOME
OIL FIELDS
FRESNO & KINGS CO'S.
CALIFORNIA
·DEPARTMENT·OF·NATURAL·RESOURCES·
·DIVISION·OF·OIL·&·GAS·
R D. BUSH, STATE OIL & GAS SUPERVISOR.
SCALE
3000 2000 1000 0 3000 6000 9000 12000 FT
Revised to
Nov 4, 1950.
Copies of this map may be purchased for $1.50 by addressing the Division of Oil & Gas, Ferry Bldg, San Francisco, 1015 W Olympic, Los Angeles, Santa Maria, Santa Paula, Coalinga, Bakersfield and Taft, California
(USL) Federal lease
LEGEND
Uncompleted drilling
Uncompleted idle
Uncompleted abandoned
Completed producing
Completed idle
Completed abandoned
Water
Uncompleted abandoned converted to water
Completed abandoned converted to water
Gas
Gas abandoned
Producing from Eocene Oil Sand
Tanks
LOCATION PLAT OF SECTION
SHOWING
WELL LOCATIONS AND NUMBERS
Standard Oil Co of Calif and Kettleman North Dome Assoc
Scale 1" = 2000
FRESNO CO.
KINGS CO.
T21S R18E K
T22S R19E R
T22S R18E Q
T22S R17E P
T23S R19E V
T23S R18E U
T23S R17E T
T24S R19E Z
T24S R18E Y
NORTH DOME
MIDDLE DOME
KETTLEMAN PLAINS
KREYENHAGEN HILLS
KINGS CO.
KERN CO.
AVENAL



GEOLOGIC COLUMNAR SECTIONS OF
PRE-TERTIARY STRATIFIED FORMATIONS IN
SAN BERNARDINO COUNTY

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

MINERAL PRODUCTION OF SAN BERNARDINO COUNTY, 1880-1950 *

San Bernardino County

Year	Gold, value	Silver, value	Copper: Pounds	Copper: Value	Lead: Pounds	Lead: Value	Borates, value	Gypsum: Tons	Gypsum: Value	Salt: Tons	Salt: Value
1880											
1881	$80,000	$100,000									
1882	20,000	150,000									
1883	30,000	1,050,000									
1884	32,000	2,550,000									
1885	33,000	2,363,436									
1886	56,464	1,204,750									
1887	27,850	1,133,263									
1888	25,000	1,200,000									
1889	10,737	621,520									
1890	17,335	795,455									
1891	62,970	711,157									
1892	47,037	87,072									
1893	155,000	447,020									
1894	130,420	148,243					$726,509			1,000	$3,000
1895	131,360	219,410					555,900			3,841	20,101
1896	96,723	190,714					650,500			3,000	15,000
1897	100,373	54,407					1,080,000				
1898	281,312	32,000					1,120,000				
1899	184,599	125,931	1,389,873	$232,319			1,106,000				
1900	247,949	172,759	1,920,000	297,600	10,000	$400	999,340				
1901	299,683	57,164	50,000	7,675	500	20	595,130				
1902	294,036	58,277	335,480	41,005	50,340	2,078	2,198,600				
1903	351,197	59,199	80,400	7,552	14,000	504	498,000				
1904	585,528	13,025	169,477	17,270							
1905	473,493	19,565	52,703	8,206							
1906	354,930	32,765	514,031	99,207							
1907	158,676	51,339	514,282	102,556	34,311	1,522					
1908	190,311	35,704	518,940	71,079	409,570	17,218		20,000	$70,000	90	650
1909	40,071	12,570	318,300	40,418	310,200	12,254		13,500	43,000	3,500	14,000
1910	55,093	10,164	8,412	659	134,317	5,973		31,519	70,357	2,000	9,000
1911	127,387	35,542	664,459	63,211	181,338	7,260		20,594	66,505	3,600	13,500
1912	293,900	49,952	1,037,185	319,530	64,553	4,268		21,000	67,000	3,600	12,600
1913	356,524	44,413	497,552	77,167	279,241	12,257		23,000	74,000	3,019	10,573
1914	205,000	40,000	19,069	2,515	45,110	1,759		17,332	49,150	452	2,992
1915	416,967	84,165	209,440	36,652	169,153	7,952				342	3,324
1916	279,913	67,145	1,577,901	388,164	673,501	46,492				7,353	15,830
1917	154,975	85,930	1,220,358	333,157	2,293,541	197,245					
1918	29,223	88,712	1,580,993	390,507	667,975	47,420					
1919	39,769	427,717	256,933	47,790	105,795	5,967		10,613	50,134		
1920	79,195	[illegible]	5,365	[illegible]	115,976	9,279	440,411			202	1,220
1921	217,568	3,210,796	17,054	2,200	22,613	1,027	335,903			13,370	67,782
1922	125,728	2,374,915	13,452	1,816	11,185	616				12,222	54,289
1923	310,923	2,225,059	13,325	1,959	34,477	2,413				17,350	63,550
1924	167,573	1,53[illegible]	17,667	2,314	31,568	2,533				29,699	99,791
1925	157,374	1,376,322	6,249	888	61,480	5,349				24,310	101,045
1926	135,475	551,644	171,232	[illegible]	183,536	15,643				22,522	55,463
1927	52,225	447,125	197,132	25,824	125,092	7,910					
1928	91,7[illegible]	382,741	106,351	15,314	39,067	2,209				42,214	158,470
1929	44,984	199,756	51,346	14,495	52,532	3,373				24,949	111,796
1930	59,442	176,498	40,622	5,281	45,653	2,263					
1931	54,699	32,453	8,072	533	15,763	593					
1932	127,979	50,241	6,183	357	33,271	70					
1933	116,074	33,917	7,471	504	27,938	1,034					
1934	301,994	147,597	35,500	2,045	103,497	3,929					
1935	279,030	114,736	14,553	1,623	123,778	4,95[illegible]					
1936	140,165	152,343	10,1[illegible]	930	115,621	5,319					
1937	218,923	277,842	29,760	3,430	106,21[illegible]	[illegible]					
1938	409,290	164,351	24,7[illegible]	2,423	[illegible]	4,089					
1939	372,820	125,547	43,133	4,486	62,3[illegible]	2,932					
1940	515,410	103,338	50,913	5,753	[illegible]	[illegible]					
1941	593,145	115,835	111,077	13,107	78,921	4,502					
1942	338,275	46,732	57,185	10,031	59,495	3,950				56,18[illegible]	473,760
1943	82,320	6,335	85,875	11,164	229,514	17,663					
1944	22,165	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
1945	[illegible]	[illegible]	[illegible]	15,0[illegible]	[illegible]	71,26[illegible]					
1946	171,5[illegible]	[illegible]	[illegible]	3,505	[illegible]	[illegible]					
1947	[illegible]	[illegible]	[illegible]	[illegible]	16,000	43,504				5[illegible]	[illegible]
1948	[illegible]	5,075	[illegible]	[illegible]	[illegible]	156,002					
1949	[illegible]	[illegible]	[illegible]	26,694	[illegible]	[illegible]					
1950	[illegible]	11,5[illegible]	[illegible]	15,[illegible]	[illegible]	8,761					
Totals	$12,119,35[illegible]	[illegible]	[illegible]	$2,6[illegible]	[illegible]	[illegible]	$10,600,[illegible]	167,514	$400,166	525,3[illegible]	$1,755,[illegible]

Year	Cement: Barrels	Cement: Value	Lime: Barrels	Lime: Value	Limestone: Tons	Limestone: Value	Brick: M	Brick: Value	Marble: Cubic feet	Marble: Value	Miscellaneous stone,[1] value	Gems, value
1894	8,000	$21,600	40,000	$32,000	5,000	$8,250					$31,622	
1895	16,253	32,356	87,664	87,674	30,000	30,000					37,673	
1896	9,000	27,000	37,427	34,977	17,500	17,500			500	$3,000	28,478	
1897	18,000	66,000	12,000	12,000								
1898	50,000	150,000	50,000	35,000	6,600	6,600	2,000	$16,500	1,200	6,000	16,040	
1899	50,000	180,000	16,000	16,100	16,449	14,810	1,000	6,000	4,500	625	11,275	
1900	32,000	121,000	76,261	33,261	7,067	7,067					65,757	$20,000
1901	71,500	159,843	38,753	43,028	54,210	76,710					166,777	20,000
1902	96,000	273,600	76,532	65,532	45,954	81,578	60	1,800	8,005	15,600	192,400	11,500
1903	100,000	157,000	39,933	28,693	52,515	64,613	100	8,900	38,000	41,600	268,961	10,000
1904			25,000	21,500	23,421	42,575	2,500	17,500	31,116	53,400	165,855	
1905			17,024	14,740	27,357	51,395			40,100	40,000	147,197	65,000
1906			20,910	17,144	19,437	35,990	1,500	13,500	7,200	25,000	39,478	
1907			5,600	5,600	74,209	179,185	1,665	15,555	6,451	29,946	147,942	
1908					104,236	97,466	1,050	7,350	150	500	231,242	200
1909					22,197	41,393	1,709	11,966	50,000	125,000	173,777	200
1910					274,010	157,715	1,910	11,460			95,126	1,120
1911					215,102	177,050			35	405	167,313	
1912	[2]2,361,000	2,996,200			60,156	97,567	1,360	9,040			550,524	450
1913			121,814	113,856	23,826	35,104	350	2,100			364,312	550
1914			81,637	93,100	23,006	20,840	25	1,250			131,973	
1915	915,000	990,000			68,500	68,500	400	2,400			174,326	
1916	1,026,000	1,216,000	151,620	81,317	65,174	[illegible]					172,454	1,000
1917	1,323,931	1,672,051									111,155	
1918	1,027,653	1,153,962			10,652	13,322					45,451	
1919	1,078,941	1,717,993									183,358	
1920	1,641,243	3,051,079									165,991	
1921	1,964,976	4,633,[illegible]			[illegible]	106,193					145,573	
1922	2,770,963	4,156,430			3,203	7,500						
1923	3,551,764	8,478,012			3,459	29,324					351,151	
1924	4,354,119	7,571,370			1,375	45,137					335,016	
1925	5,079,281	8,824,414	17,415	124,416	13,253	37,569					335,045	
1926	5,135,847	9,273,627	13,549	98,319	11,2[illegible]	49,504					404,651	
1927	5,855,339	9,823,[illegible]	17,175	92,503	[illegible]	145,354					311,470	
1928	4,603,363	[illegible]	14,0[illegible]	[illegible]	11,201	40,2[illegible]					329,541	
1929	3,576,805	6,603,501	19,145	77,340	15,520	40,753					529,111	1,540
1930											406,912	
1931					15,135	56,50[illegible]					486,245	
1932					[illegible]	23,7[illegible]					137,250	
1933											145,154	
1934			3,466	30,516	11,213	29,719					163,037	
1935											199,292	
1936					19,046	52,046					299,357	
1937					[illegible]	76,850					307,337	
1938											279,515	
1939											173,963	
1940											174,414	
1941					30,603	83,500					306,504	
1942					47,678	119,550					2,075,901	
1943					50,511	112,099					837,463	
1944					[illegible]	[illegible]					521,919	
1945					[illegible]	255,527					[illegible]	
1946					[illegible]	556,841					505,[illegible]	
1947			167,324	[illegible]							[illegible]	
1948			145,707	[illegible]							[illegible]	
1949			117,511	297,943							[illegible]	
1950					[illegible]	553,20[illegible]						
Totals	[illegible]	[illegible]	1,156,268	$3,27[illegible]	3,257,472	$1,972,165	$113,909	$125,[illegible]	185,788	$312,076	$10,105,180	$131,660

Miscellaneous and unapportioned

Year	Amount	Value	Substance
1904	4,000 cu. ft.	$2,000	Sandstone
1906	10 tons	5,500	Tungsten
1909	300 tons	3,000	Pottery clay
		4,035,856	Unapportioned, 1900-1909
1910	430 tons	4,300	Pottery clay
	109,000 gals.	25,000	Mineral water
	60 tons	840	Barytes
	100 tons	1,000	Soapstone
1911	920 tons	4,068	Pottery clay
1912	350 tons	350	Pottery clay
	200 tons	1,200	Mineral paint
1913	50 tons	550	Barytes
	4,500 gals.	3,000	Mineral water
		1,391,394	Other minerals
1914	44,100 gals.	5,100	Mineral water
	60 tons	561	Mineral paint
	140 tons	400	Glass sand
		1,240,575	Other minerals
1915	37,450 gals.	7,350	Mineral water
	864 tons	540,247	Tungsten concentrates
	39,949 lbs.	4,941	Zinc
		42,316	Dolomite, gypsum, lime, manganese, marble, mineral paint, soapstone, and talc
1916	7,500 cu. ft.	2,500	Granite
	40,500 gals.	8,500	Mineral water
	1,071 tons	2,915,434	Tungsten concentrates
	707,062 lbs.	94,766	Zinc
		217,265	Brick, dolomite, feldspar, gypsum, manganese, mineral paint, pumice, potash, talc, strontium
1917		2,350	Granite
		187,571	Lime and limestone
	235 tons	6,050	Manganese
	31,300 gals.	1,520	Mineral water
	14,570 tons	2,589,120	Potash
	3,050 tons	37,000	Strontium
	1,943 tons	2,467,724	Tungsten concentrates
	35,735 lbs.	3,931	Zinc
		114,514	Brick, pottery clay, dolomite, feldspar, gems, gypsum, iron ore, mineral paint, salt, soda, talc
1918	270 tons	410	Dolomite
	101,500 gals.	60,150	Mineral water
	27,545 tons	3,429,483	Potash
	430 tons	4,210	Talc
	3,600 tons	33,000	Strontium
	1,347 tons	1,911,966	Tungsten concentrates
	3,921 lbs.	357	Zinc
		122,245	Gems, granite, gypsum, iron ore, lime, magnesite, marble, mineral paint, salt
1919	100,000 gals.	32,906	Mineral water
	31,171 tons	1,579,919	Potash
	3,601 tons	19,835	Talc
		463,492	Borax, pottery clay, dolomite, gems, lime, tungsten
1920	95 tons	[illegible]	Pottery clay
	110,100 gals.	158,796	Mineral water
	15,435 tons	1,182,037	Potash
		335,551	Dolomite, gems, granite, gypsum, iron ore, lime, [illegible] talc
1921	[illegible]	[illegible]	[illegible]
	2,750 tons	[illegible]	Talc
		[illegible]	Pottery clay, dolomite, feldspar, gems, granite, gypsum, iron ore, lime, mineral water, pumice, soda, [illegible]
1922		326,534	Borax, calcium chloride, fuller's earth, gems, gypsum, lime, mineral water, potash, soda, talc, [illegible]
1923	830 tons	12,030	Clay (pottery)
	7,245 tons	[illegible]	Talc
		2,765,[illegible]	Borates, calcium chloride, gems, gypsum, lime, mineral water, potash, soda (trona), tungsten concentrates
1924	7,234 tons	123,929	Talc
		2,720,263	Borates, calcium chloride, clay (pottery), fuller's earth, gypsum, lime, mineral water, petroleum, potash, soda (trona), tungsten concentrates
1925		11,000	Clay (pottery)
	1,540 tons	[illegible]	Talc
		3,150,[illegible]	Borates, calcium chloride, fuller's earth, mineral water, petroleum, potash, soda (trona), talc, tungsten concentrates
1926	2,268 tons	19,063	Clay (pottery)
	2,406 tons	71,221	Soda (trona)
	5,034 tons	112,250	Talc
		3,291,[illegible]	Borates, calcium chloride, fuller's earth, magnesite, mineral water, petroleum, potash, silica, tungsten concentrates, zinc
1927	[illegible] tons	[illegible]	Fuller's earth
	6,544 tons	49,450	Talc
		4,723,551	Borates, calcium chloride, clay (pottery), gems, mineral water, onyx, petroleum, potash, salt, silica, soda (trona), talc, tungsten concentrates
1928	2,190 tons	13,215	Clay (pottery)
		3,573,833	Antimony, borates, calcium chloride, fuller's earth, gems, mineral water, potash, soda, talc, and tungsten
1929	3,556 tons	15,674	Clay (pottery)
		5,474,419	Barite, borates, calcium chloride, manganese, mineral water, potash, volcanic ash, soda, talc, tungsten
1930	2,013 tons	14,910	Clay (pottery)
		9,993,9[illegible]	Barite, borates, brick, calcium chloride, cement, fuller's earth, gems, lime, limestone, manganese ore, mineral water, potash, salt, soda, talc, tungsten
1931	3,035 tons	20,753	Bentonite
	1,220 tons	5,333	Pottery clay
		9,299,304	Barite, borates, brick, calcium chloride, cement, gems, lime, manganese ore, mineral water, potash, pumice, iron ore, salt, silica, quartz, soda, talc, tungsten
1932	1,096 tons	6,4[illegible]	Pottery clay
		3,626,559	Barite, bentonite, borates, brick, calcium chloride, cement, gems, lime, mineral water, petroleum, potash, salt, soda, talc
1933	275 tons	2,5[illegible]	Barite
	1,675 tons	16,042	Bentonite
	786 tons	[illegible]	Pottery clay
	5,531 tons	[illegible]	Talc
		3,563,3[illegible]	Borates, brick, calcium chloride, cement, fluorspar, lime, limestone, mineral water, petroleum, potash, soda ash, salt, soda, tungsten
1934	1,153 tons	7,514	Pottery clay
		9,848,998	Barite, bentonite, borates, brick, calcium chloride, cement, fluorspar, gems, iron ore, manganese, mineral water, potash, salt, soda, talc, tungsten ore
1935	4,029 tons	[illegible]	Bentonite
	2,623 tons	[illegible]	Pottery clay
		9,223,4[illegible]	Borates, brick, calcium chloride, cement, iron ore, lime, limestone, onyx, mineral water, potash, salt, soda, talc, tungsten ore
1936	4,974 tons	[illegible]	Bentonite
	9,781 tons	[illegible]	Pottery clay
		4,5[illegible]	Borates, brick, calcium chloride, cement, gems, iron ore, lime, onyx, mineral water, petroleum, potash, salt, soda, talc, tungsten ore, zinc
1937	5,765 tons	[illegible]	Pottery clay
	17,279 lbs.	[illegible]	Zinc
		15,[illegible]	Bentonite, borates, brick, calcium chloride, cement, fluorspar, granite, iron ore, lime, onyx, mineral water, salt, soda, talc, tungsten ore
1938	8,504 tons	[illegible]	Bentonite
	3,65[illegible] tons	[illegible]	Pottery clay
		15,[illegible]	Barite, borates, calcium chloride, cement, granite, iron ore, lithia, lime, limestone, onyx, mineral water, petroleum, potash, salt, serpentine, tungsten ore, zinc
1939	8,924 tons	44,0[illegible]	Pottery clay
		13,957,462	Antimony, bentonite, borates, brick, calcium chloride, cement, marble, iron ore, lime, limestone, lithia, mineral water, petroleum, potash, salt, soda, strontium, talc, tungsten ore, zinc
1940	4,733 tons	[illegible]	Bentonite
	7,043 tons	[illegible]	Pottery clay
	31,955 tons	[illegible]	Talc
		11,5[illegible]	Antimony, borates, brick, bromine, calcium chloride, cement, feldspar, granite, lime, limestone, lithia, manganese ore, marble, mineral water, petroleum, potash, quicksilver, salt, soda, strontium, tungsten ore
1941	10,451 tons	97,98[illegible]	Bentonite
	5,240 tons	71,656	Pottery clay
	26,681 tons	263,742	Talc
		15,371,603	Antimony, borates, brick, bromine, calcium chloride, cement, feldspar, granite, iron ore, lime, lithia, manganese ore, mineral paint, mineral water, potash, quicksilver, salt, quartz, soda, strontium, tungsten ore
1942	5,032 tons	45,351	Bentonite
	4,739 tons	32,224	Pottery clay
	17,594 tons	85,709	Talc
	10,769 units	721,6[illegible]	Tungsten ore
	578,411 lbs.	53,837	Zinc
	229,941 tons	3,63[illegible]	Soda, soda ash and salt cake
		17,537,143	Antimony, borates, brick, bromine, calcium chloride, cement, feldspar, gems, granite, iron ore, lithia salts, manganese ore, mineral paint, mineral water, potash, petroleum, sandstone, silica (quartz) not including ganister, strontium
1943	804,745 tons	1,721,827	Iron ore
	32,660 tons	138,023	Talc
	28,172 units	772,229	Tungsten ore
	1,465,134 lbs.	155,214	Zinc
		17,575,284	Bentonite, borates, brick, bromine, calcium chloride, cement, clay pottery, feldspar, gems, granite, lithia, manganese ore, mineral water, petroleum, potash, salt, silica (quartz and ganister), soda, strontium
1944	3,573 tons	[illegible]	Pottery clay
	2,802 long tons	67,055	Manganese ore
	29,151 tons	107,142	Silica, quartz and glass sand
	[illegible] tons	417,343	Talc
	[illegible] lbs.	[illegible]	Zinc
		21,021,[illegible]	Bentonite, borates, brick, bromine, calcium chloride, cement, feldspar, granite, iron ore, lithia, mineral paint, mineral water, potash, salt, salt cake, soda ash, strontium, tungsten ore
1945	4,637 tons	[illegible]	Pottery clay
	24,911 tons	445,512	Talc
	[illegible] lbs.	[illegible]	Zinc
		21,365,[illegible]	Bentonite, borates, brick, bromine, calcium chloride, cement, feldspar, granite, iron ore, lithia, mineral paint, mineral water, potash, salt, silica, quartz, soda ash, salt cake, strontium, tungsten ore
1946	16,577 tons	101,855	Pottery clay
	[illegible] tons	122,739	Talc
	[illegible] lbs.	151,175	Zinc
		[illegible]	Bentonite, borates, brick, bromine, calcium chloride, cement, gems, granite, iron ore, lithia, mineral paint, mineral water, potash, salt, soda ash, salt cake, strontium, tungsten ore
1947	[illegible]	[illegible]	Calcium chloride
	[illegible]	[illegible]	Clay, raw
	[illegible]		Coke
	[illegible]		Iron ore
	[illegible]		Iron pig
	[illegible]	1,121,[illegible]	Sand and gravel
	[illegible]	[illegible]	Talc
	[illegible]	[illegible]	Zinc
		42,220,545	Boron minerals, bromine, cement, iron ore, lithium minerals, petroleum, potassium salts, silica (quartz), sodium salts, tungsten concentrates
1948	[illegible]	167,6[illegible]	Calcium chloride
	[illegible]	[illegible]	Clay, raw
	[illegible]		Coke
	[illegible]		Iron ore
	[illegible]		Iron pig
	[illegible]	1,640,[illegible]	Sand and gravel
	[illegible]	1,160,[illegible]	Talc
	[illegible]		Tungsten concentrates
	[illegible]	85,254	Zinc
		39,058,100	Boron minerals, bromine, cement, feldspar, iron ore, lithium minerals, petroleum, potassium salts, silica (quartz), sodium salts, tungsten concentrates. Coke and iron pig not included in this value
1949	[illegible]	201,011	Calcium chloride
	[illegible]	111,5[illegible]	Clay
	[illegible]		Iron ore
	[illegible]		Manganese ore
	[illegible]	12,1[illegible]	Pumice and pumicite
	[illegible]	1,063,0[illegible]	Sand and gravel
	[illegible]	791,411	Talc
	[illegible]		Tungsten concentrates
	[illegible]	76,669	Zinc
		75,244,[illegible]	Boron minerals, bromine, cement, feldspar, iron ore, lithium minerals, manganese ore, perlite, petroleum, potassium salts, pumice, salt, sodium salts, tungsten concentrates
1950	[illegible]	231,472	Clay or fuller's earth
	[illegible]	1,032,[illegible]	Sand and gravel
	[illegible]	1,466,[illegible]	Talc
	[illegible]	16,500	Zinc
		41,532,[illegible]	Borates, bromine, calcium chloride, cement, feldspar, granite, iron ore, lime, lithium minerals, perlite, petroleum, potash, pumice, quartz, salt, salt cake, sodium carbonate, stone, tungsten ore
Totals		$177,150,621	

[1] Includes crushed rock, rubble, riprap, sand and gravel.
[2] [illegible] annual production 1910, 1911, 1912.
[3] See under "Unapportioned."
* Statistics for years 1880-1914 taken from California Div. Mines Bull. 100, 1915.

STATE OF CALIFORNIA
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DEPARTMENT OF NATURAL RESOURCES
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DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 49 | JULY 1953 | No. 3

CALIFORNIA JOURNAL
OF
MINES AND GEOLOGY

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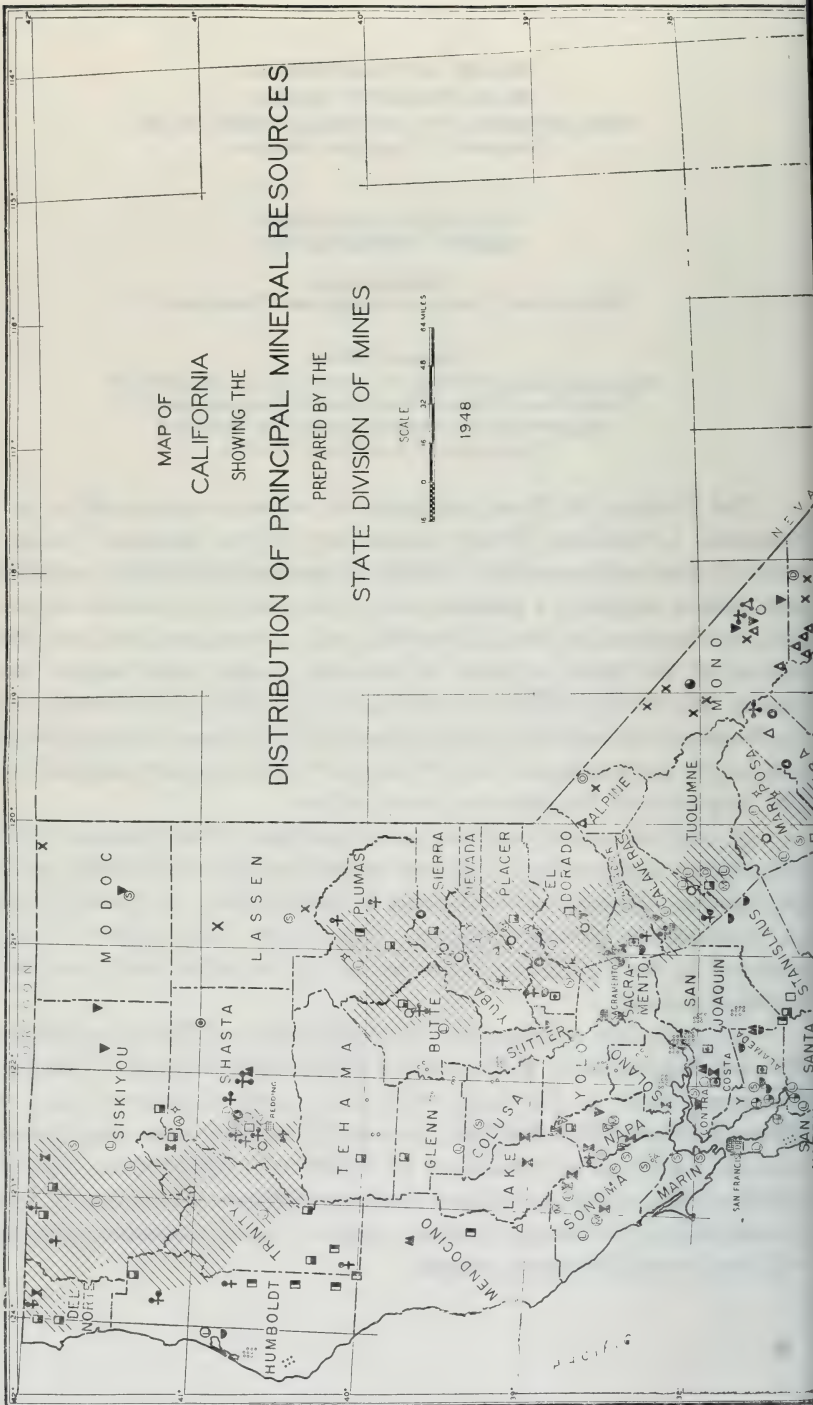
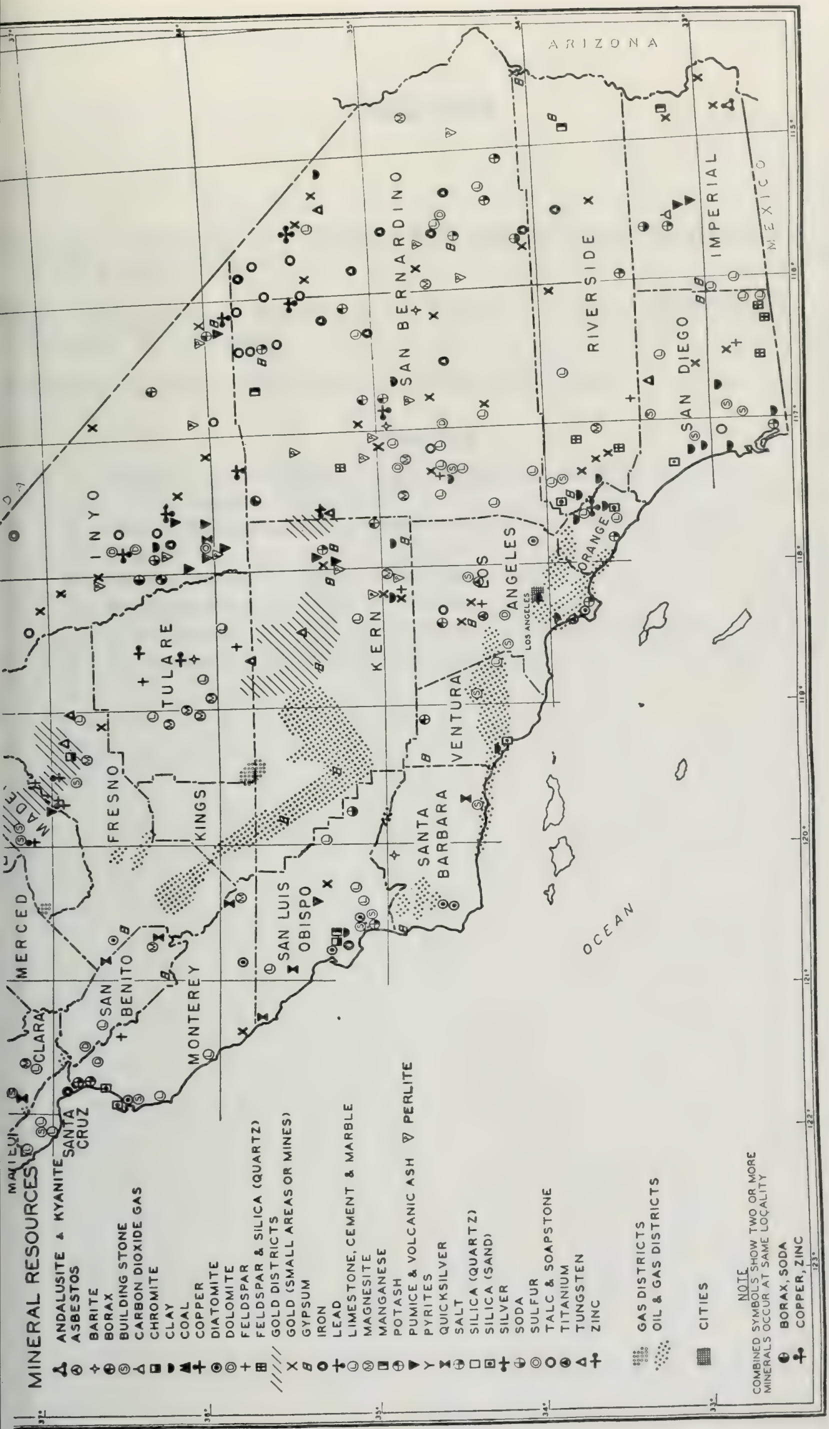
The Division of Mines maintains at its headquarters offices in San Francisco a technical library containing several thousand books and scientific journals on geology, mining, mineralogy, chemistry, metallurgy, and related subjects; a reading room containing periodicals devoted to the petroleum and mining industries, and newspapers from the mining centers of the state; exhibits of minerals, rocks, mine models, etc.; a service laboratory for the determination of California minerals; and a conference room with a mining engineer in attendance to serve the public and to sell publications of the Division. Publications are also sold at the Los Angeles and Sacramento branch offices.

In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

The principal publications of the Division of Mines are **Bulletins**, **Special Reports**, and the quarterly **California Journal of Mines and Geology**, issued in January, April, July, and October of each year. **Mineral Information Service** is a monthly news release concerning the mineral resources and industry of California, designed to inform the public of discoveries, operations, markets, statistics, and new publications. It is distributed without cost upon request. A list of available publications will also be sent free upon request.


MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
1948
MODOC
SISKIYOU
SHASTA
LASSEN
TRINITY
DEL NORTE
HUMBOLDT
TEHAMA
PLUMAS
BUTTE
GLENN
MENDOCINO
COLUSA
LAKE
SIERRA
NEVADA
PLACER
YUBA
SUTTER
YOLO
EL DORADO
SACRAMENTO
SONOMA
NAPA
SOLANO
MARIN
ALPINE
AMADOR
CALAVERAS
TUOLUMNE
MONO
MARIPOSA
SAN JOAQUIN
STANISLAUS
CONTRA COSTA
ALAMEDA
SAN FRANCISCO
SANTA
NEVADA
OREGON
REDDING


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY
BORAX, SODA
COPPER, ZINC
ARIZONA
MEXICO
OCEAN
INYO
SAN BERNARDINO
RIVERSIDE
IMPERIAL
SAN DIEGO
ORANGE
LOS ANGELES
KERN
TULARE
FRESNO
KINGS
MADERA
MERCED
SAN BENITO
MONTEREY
SAN LUIS OBISPO
SANTA BARBARA
VENTURA
SANTA CLARA
SANTA CRUZ
LOS ANGELES

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PLATES

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FLOTATIVE PROPERTIES OF TITANIUM MINERALS IN OLEATE SOLUTIONS†

By V. S. Pradhan * and D. W. Mitchell **

Although numerous descriptions of flotation testing of titanium ores have been published, and commercial flotation of ilmenite has recently been described, to the writers' knowledge there is no published information on the flotative behavior of pure titanium minerals. In this paper the results of captive bubble and batch flotation tests with titanium minerals in dilute oleate solutions are given.

Captive Bubble Tests. The minerals used in the measurement of contact angles were natural rutile, brookite, and ilmenite, and artificial rutile. The artificial rutile was a single crystal loaned by Professor George Jura of the Chemistry Department of the University of California. Contact angles were obtained with polished surfaces of minerals mounted in leucite briquettes. In each case, before contact angles in oleate solution were measured, the mineral surface was polished on a specially cleaned linen lap until zero contact angle was obtained in distilled water. Actual measurement of angles was made on the table of an adapted machinist's contour projector onto which an image of the mineral-bubble contact was projected. Angle measurements were made on both sides of the image at three different positions on the mineral surface. The average of the six readings so obtained was taken as the contact angle. Conditioning was performed in a beaker of the collector solution agitated by a glass stirrer. After conditioning, the specimen was transferred to the contact bubble cell with clean glass tongs. The solution in the conditioning vessel and in the contact bubble cell were identical, containing collector reagent at the desired concentration and having the pH adjusted to the predetermined value. It was determined by experiment that equilibrium-contact angles were developed after 30 minutes conditioning time, but that angles only slightly smaller than those at equilibrium were developed in 8 to 10 minutes.

Reagents used were Bakers' U.S.P. purified grade sodium oleate as collector, and C.P. sodium hydroxide and hydrochloric acid for adjusting the pH.

The sodium oleate concentration to be used in subsequent experiments was indicated by the results of a series of contact angle measurements in solutions of sodium oleate at concentrations from zero to 200 mg per liter. The pH in these solutions was 7.4 to 8.1. For each of the natural minerals, rutile, brookite, and ilmenite, the maximum contact angle was obtained at approximately 50 mg of sodium oleate per liter of solution. Table 1 summarizes the data on the effect of oleate concentration on the contact angle. From the table it is apparent that, although the contact angle is dependent upon oleate concentration, flotation of these minerals under the conditions of the contact angle measurements would be possible over a considerable range of oleate concentrations, as maximum contact angles are not required for effective flotation concentration.

† Portion of a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at the University of California, Berkeley. Manuscript submitted for publication August 1951.

* Indian Government Scholar at the University of California.
** Associate Professor of Metallurgy, University of California, Berkeley.

Table 1. Effect of sodium oleate concentration on air bubble contact angle against titanium minerals in distilled water.

Sodium oleate concentration (mg/liter)	Contact angle (degrees)		
	Rutile	Brookite	Ilmenite
0	0	0	0
10	52	48	54
25	61	57	59
50	70	64	70
100	60	59	69
200	60	54	53

pH 7.4 to 8.1

To determine the optimum pH for air-mineral contact, captive bubble tests were made with the titanium minerals in sodium oleate solutions of the same concentration, 50 mg per liter, and of different pH values ranging from 3 to 11. As can be seen from figure 1, the critical pH above which contact between air bubble and mineral does not occur is in the neighborhood of 10 for artificial rutile, and natural rutile, brookite, and ilmenite. The exact value of the critical pH lies between 8.5 and approximately 10.5. No values of contact angles at intermediate pHs were obtained because of the uncertainty in establishing the existence or non-existence of contact at small contact angles. However, the change in contact angle with pH between 8.5 and 10 is rapid. Maximum contact angles for all the titanium minerals tested occur at approximately pH 8. No angle smaller than 49° was found in acid solutions with pH greater than 3. Solutions more acid than pH 3 were not used. The titanium minerals tested are all readily flotable in the pH range 3 to 8.5. The almost identical behavior observed for synthetic rutile and the natural titanium minerals is noteworthy.

Batch Flotation Tests. Batch flotation tests using high-grade titanium-mineral concentrates and mixtures of titanium minerals and quartz

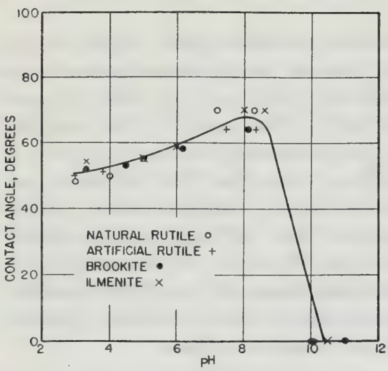

FIGURE 1. Effect of pH on air bubble contact angle against titanium minerals in 50 mg per liter sodium oleate solution.

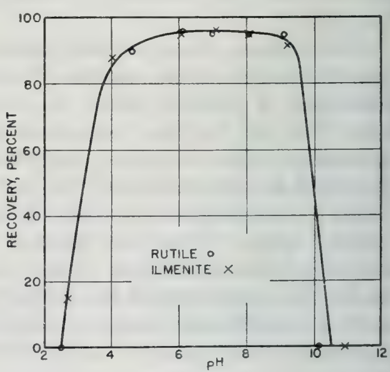

FIGURE 2. Effect of pH on flotation of rutile and ilmenite in dilute sodium oleate solution. Pulp density 20 percent, sodium oleate 0.5 lb. per ton, pine oil 0.1 lb. per ton.

Table 2. Flotation of rutile from synthetic mixture of quartz and rutile (70 percent quartz, 30 percent rutile concentrate).

pH	Concentrate assay (percent TiO_2)	Recovery of TiO_2 (percent)
2.1	0	0
4.15	78.4	67.8
6.1	91.0	92.8
7.05	96.1	95.5
8.0	96.5	96.4
10.0	0	0

Collector:	Sodium oleate	0.5 lb./ton
Frother:	Pine oil	0.1 lb./ton
Modifier:	Sodium silicate	1.0 lb./ton

Table 3. Flotation of ilmenite from synthetic mixture of quartz and ilmenite (70 percent quartz, 30 percent ilmenite concentrate).

pH	Concentrate assay (percent TiO_2)	Recovery of TiO_2 (percent)
2.1	0	0
4.1	34.6	59.8
5.9	43.5	70.1
7.8	47.6	86.2
9.1	46.3	85.1
10.0	47.0	65.0
11.5	0	0

Collector:	Sodium oleate	0.5 lb./ton
Frother:	Pine oil	0.1 lb./ton
Modifier:	Sodium silicate	0.5 lb./ton

were made to compare with the results of the captive bubble tests. Since quartz is not a soap-floating mineral unless activated by adsorbed cations, it should be possible to make practically complete separations of titanium minerals from quartz (and other gangue minerals not floated by soaps) using oleate as collector.

The rutile and ilmenite used in these tests were obtained through the courtesy of the Titanium Division of the National Lead Company. The rutile was a gravity concentrate from Florida assaying 93.6 percent TiO_2 and the ilmenite a concentrate of McIntyre ilmenite from Tahawas, New York, assaying 44.6 percent TiO_2. Quartz sand from Monterey, California, leached with hydrochloric acid and washed with distilled water was used as the gangue material.

Flotation charges were prepared by stage grinding the minerals or mineral mixtures in an Abbe pebble mill to give 95 to 98 percent -150 mesh products. Flotation testing was performed in a 50-gram laboratory cell made of leucite and wood. The wood parts and impeller were painted with leucite paint. The cell was thoroughly cleaned with warm sodium carbonate solution before use.

The test procedure consisted of conditioning for 8 minutes with 0.5 lb. sodium oleate per ton of solids, adding 0.1 lb. pine oil per ton and further conditioning for a short time. Froth was skimmed for 2 minutes. Pulp density was 20 percent solids. All tests were simple rougher tests.

Results of batch flotation testing with pure minerals confirmed the contact angle measurements. Rutile and ilmenite floated readily between pH values of 4 to 9, recoveries of 95 and 96 percent being obtained in this pH range. Rutile did not float at all at pH 2.5 or 10.1 and only 15 percent recovery was obtained with ilmenite at pH 2.7. At pH 10.9 ilmenite did not float. Results of these tests are shown graphically in figure 2.

With synthetic mixtures of rutile and quartz, and of ilmenite and quartz, and the same reagents as before plus sodium silicate for depressing silica, the results given in tables 2 and 3 were obtained. In both series of tests the best grade and recovery were obtained at pH 7 to 8. Rutile recoveries were as high as with the single mineral, but ilmenite recoveries were considerably lower, presumably because of some depression by sodium silicate.

Summary. Similarity in the flotation behavior of synthetic rutile and the natural minerals rutile, brookite, and ilmenite is shown from contact-angle measurements and simple rougher flotation tests with single minerals and synthetic mixtures.

Natural rutile and synthetic rutile have the same adsorption behavior towards solutions of sodium oleate in the pH range 3 to 10, and rutile, brookite, and ilmenite have practically the same flotative properties in dilute solutions of sodium oleate. Rutile and ilmenite may be effectively separated from quartz by froth flotation, using sodium oleate as collector, at least in synthetic mixtures of the pure minerals. The critical pH above which air-mineral adhesion does not occur in dilute oleate solution is between 8.5 and 10.5 for rutile, brookite, and ilmenite.

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MINES AND MINERAL RESOURCES OF KINGS COUNTY, CALIFORNIA

By Charles W. Jennings *

OUTLINE OF REPORT

Illustrations

ABSTRACT

Kings County lies in the San Joaquin Valley half way between Los Angeles and San Francisco. It falls within two of the major geomorphic provinces of California —the Great Valley and the Coast Ranges. These provinces differ radically from one another in their geographic and geologic characteristics. Geologically, Kings County consists principally of a thick accumulation of sediments ranging in age from Jurassic to Recent. Many of the sediments contain marine fossils, attesting to the ancient seas which at times extended into the area. The rock units exposed at the surface include the Franciscan group (Upper Jurassic?), Panoche (Upper Cretaceous), Avenal sandstone (Eocene), Kreyenhagen shale (Eocene), Temblor sandstone (Miocene), McLure shale (Miocene), Reef Ridge shale (Miocene-Pliocene), Jacalitos (Pliocene), Etchegoin (Pliocene), San Joaquin (Pliocene), Tulare (Pliocene-Pleistocene), and Quaternary alluvium and lake sediments.

Kings County ranks high among California's 58 counties in value of mineral production. Petroleum and gas from the world-famous Kettleman Hills provide the greatest part of the county's total mineral wealth. The Pyramid Hills oil field is a more recent discovery and has become an important producing area. Dudley Ridge, Reef Ridge, Hanford, and Harvester have been sites of active search for oil and gas and numerous exploratory wells are drilled annually in Kings County in search for additional productive areas.

The mining of gypsite for use as a soil conditioner in agriculture is at present the principal mining activity in Kings County. Quicksilver production, once of significance, has been dormant since World War II. Deposits of chromite, magnesite, sand and gravel are known, but there has been no recent production from them.

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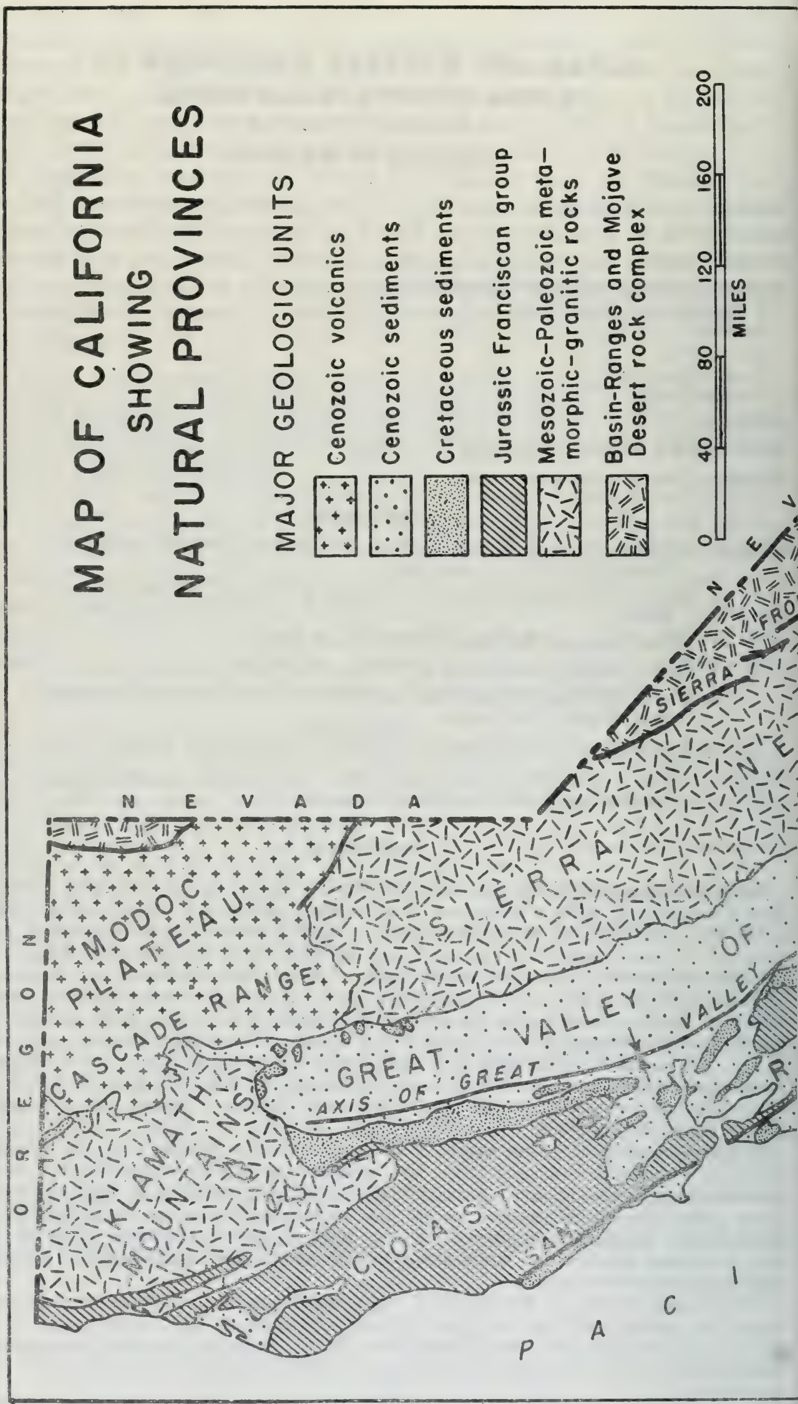

MAP OF CALIFORNIA
SHOWING
NATURAL PROVINCES
MAJOR GEOLOGIC UNITS
Cenozoic volcanics
Cenozoic sediments
Cretaceous sediments
Jurassic Franciscan group
Mesozoic–Paleozoic metamorphic–granitic rocks
Basin-Ranges and Mojave Desert rock complex
0 40 80 120 160 200
MILES
OREGON
NEVADA
MODOC PLATEAU
CASCADE RANGE
KLAMATH MOUNTAINS
SIERRA
GREAT VALLEY
AXIS OF GREAT VALLEY
COAST

FIGURE 1. Map of California showing natural provinces, major geologic units, and location of Kings County (dotted).

INTRODUCTION

Kings County is noted for its oil wells and prosperous farms. Day and night oil is pumped from the world-famous Kettleman Hills oil field through long pipe lines to metropolitan refineries and coastal shipping points, while gas flows continuously to heat the furnaces of cities as far away as Oakland and San Francisco. The never-ceasing geologic processes have also provided Kings County with a rich alluvial soil which has enabled the farmer to make a vast garden in the valley. Kings County thus ranks high among California's 58 counties in its natural and man-made resources.

Geography. Kings County was formed in 1893 from a part of Tulare County. In 1903 it was enlarged by the addition of 118 square miles from Fresno County thereby making up a total of 1396 square miles. The county lies in the heart of the San Joaquin Valley, midway between Los Angeles and San Francisco and is bounded by Fresno, Kern, Tulare, and Monterey Counties. Hanford is the largest town and county seat.

The climate is uniformly semi-arid with hot dry summers, mild, moist, foggy winters, and a seasonal rainfall of less than 10 inches. Summer temperatures range from 90° to 112° Fahrenheit; July and August are the two hottest months.

Kings County lies within two major geomorphic provinces of California—the Great Valley of California province, which includes the entire eastern and central parts of the county, and the Coast Ranges province in western Kings County. In this area the Great Valley of California can be further subdivided into two smaller but distinct units which are referred to as the Kings River alluvial fan and the Tulare Lake basin.

The vast surface of the Kings River fan—a huge, almost flat mass of alluvial material which was deposited by the Kings River—is much dissected and cut by shallow meandering sloughs and creeks.

Tulare Lake, at the terminus of the Kings River, was originally one of the largest lakes in California but has been greatly restricted by dikes and by diversion of water for irrigation. In recent years the lake almost dried up, but in the spring of 1952 its basin was again flooded when levees were ruptured by the enormous volumes of water released by the thawing of heavy Sierran snows.

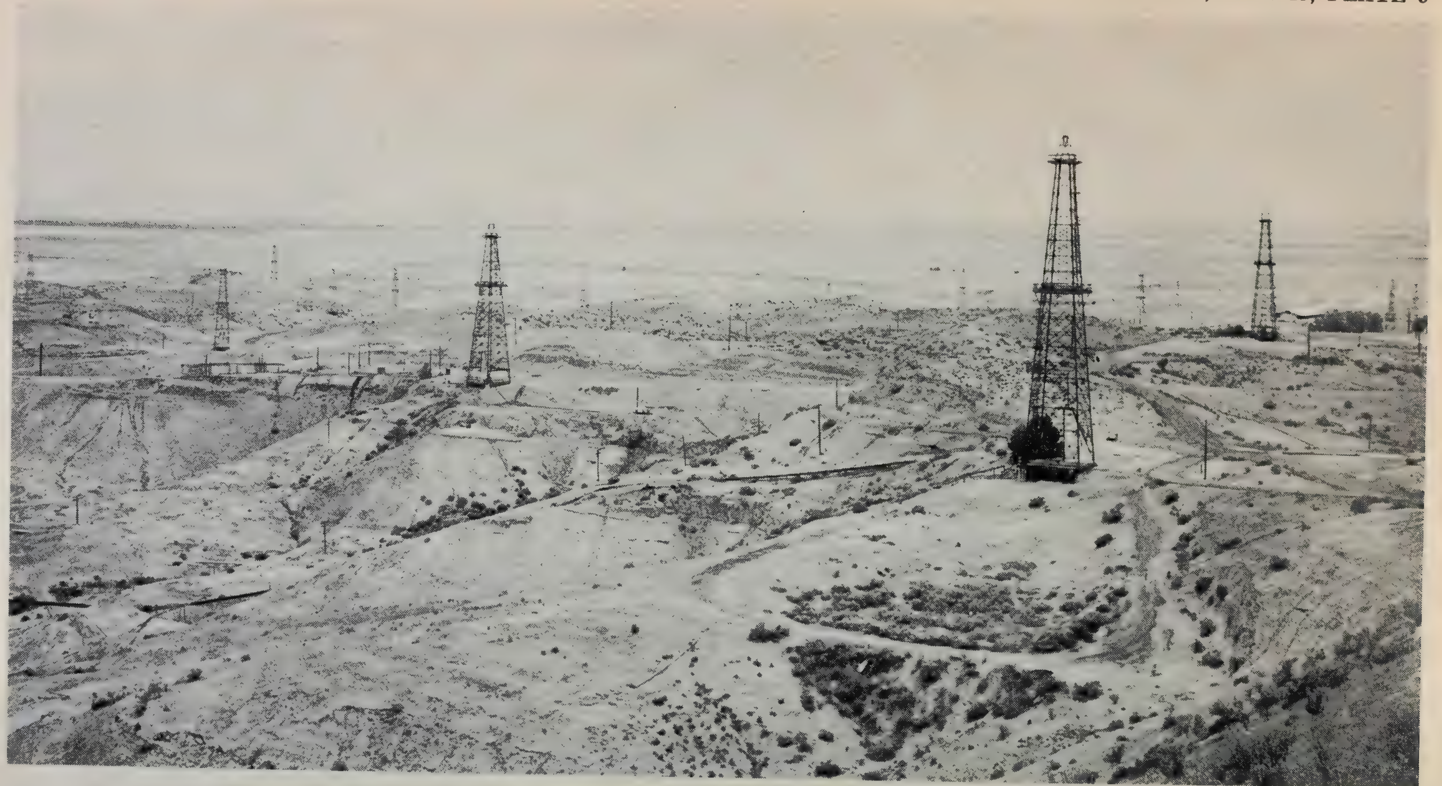
Only a small part of Kings County lies in the Coast Ranges. It includes the Kettleman Hills and a small part of the Diablo Range. The Kettleman Hills, which extend in a northwest direction, consist of three anticlines—North Dome, Middle Dome, and South Dome, lying en echelon along the west side of southern San Joaquin Valley. The northern end of North Dome is in Fresno County, and the southern end of South Dome extends into Kern County. To the west lie the Kreyenhagen Hills—low foothills at the base of the Diablo Range which are separated from the Kettleman Hills by Kettleman Plain. Reef Ridge, a prominent narrow ridge, forms the easternmost escarpment of the Diablo Range.

History. Comandante Fages, a Spanish soldier from one of the coastal settlements is said to have been one of the first white men to enter the San Joaquin Valley in the area of what today is Kings County (Bancroft 1884). In 1773, Fages discovered a large shallow lake with an abundant growth of tules or rushes in and around its shores, which prompted him

KETTLEMAN HILLS NORTH DOME. VIEW SOUTHEAST

EAST FLANK OF McLURE SYNCLINE
View southeast toward Kettleman Plain.

McLURE SHALE OVERLAIN BY TEMBLOR FORMATION
West side of Big Tar Canyon.



EAST FLANK OF KETTLEMAN HILLS, NORTH DOME OIL FIELD

View showing Etchegoin, San Joaquin, and Tulare formations dipping northeast toward San Joaquin Valley. *Photo courtesy of Standard of California.*

to name the lake Los Tules. Subsequently, the name was changed to Tulare Lake; and, although the large shallow body of water is intermittently dry, the general region is still referred to as Tulare Lake or Tulare Lake basin.

The first settlers found abundant game and waterfowl in the San Joaquin Valley. Tulare Lake contained many edible fishes, and Indians fished there and hunted ducks along its edges. It is said that in 1805, a Spanish exploration party from the Presidio at San Francisco discovered Kings River and named it "Rio de Los Santos Reyes" (River of the Holy Kings). In 1826, the first entry into the San Joaquin Valley from the east was made by Jedediah S. Smith, and in 1841 John C. Fremont made his way up the valley.

Industries. The gold rush of 1849 was the chief factor in bringing settlers to the San Joaquin Valley and to the area that is now Kings County. At first cattle and sheep raising were the main agricultural pursuits, but wheat soon became the principal product. Settlers began to inhabit the land along the edge of the Tulare Lake bed and gradually the dry lake bottom was planted with grain. Later the introduction of alfalfa into Kings County stimulated dairying and helped form a more diversified agriculture including fruits and cotton. The discovery of oil in the Kettleman Hills in 1928 added greatly to the importance and wealth of the county. Today the Kettleman Hills oil field is one of the most important in California. In addition to its oil production, this field is a large gas producer, supplying San Francisco, Oakland, Fresno, and Hanford.

GEOLOGIC HISTORY

The eastern part of Kings County lies in the San Joaquin Valley and is covered by a blanket of alluvium. Fresh-water Quaternary lake sediments make up the vast central area which is called the Tulare Lake basin. Beneath the cover of Recent sediments lies an immense thickness of strata which have accumulated in the structural trough of the Great Valley of California from early Cretaceous times to the present. This immense valley was a sea during much of its early history while the Coast Ranges were being formed. During its later history it was a great bay or series of lakes, salt water filling some, brackish or fresh water filling others.

The foregoing geologic history of the San Joaquin Valley has been deduced mainly from a study of fossils obtained from drill cores of numerous deep wells and from a regional study of the valley. These data are well summarized by Reed (1933, p. 19) who states:

"* * * During the time from early Pliocene to the present the central San Joaquin Valley was the site of deposition of marine and nonmarine silts, which now lie almost in the attitude of deposition. The gentle structure suggests that the basement, like the Sierra Nevada, is little fractured; it suggests, in fact, that the basement is a continuation of the Sierra Nevada. That strata of Miocene age underlie the Pliocene is practically demonstrated by the occurrence of Miocene beds, different in facies but with equivalent paleontological zones, along both sides of the valley and around its southern end. Pre-Miocene strata occur along the west and south sides of the valley but do not extend northward along the east side. The eastern edges of Eocene and Cretaceous formations, in other words, lie somewhere under the cover of younger deposits except in the northernmost part of the San Joaquin Valley."

On the west side of Kings County the Kettleman Hills rise gently from the valley floor and form a prominent isolated range of hills where the

Pliocene and Pleistocene strata are well exposed. West of Kettleman Hills lies Kettleman Plain beneath which the strata are gently bowed into a synclinal fold. The strata appear again at the surface in the Kreyenhagen Hills and Reef Ridge area in the westernmost part of Kings County. A description of the various formations encountered in Kings County is given below.

Franciscan Group (Upper Jurassic?). Franciscan rocks, so typical of the California Coast Ranges, crop out in the Diablo Range in the western part of Kings County. The rocks consist primarily of fine sediments, chert, basic volcanic rocks now converted to greenstone, and various metamorphic rocks. Nearly all the contacts with the adjacent Cretaceous formation are faults. The Franciscan shale, sandstone, and conglomerate are darker in color and more massive than the Cretaceous sediments.

Large bodies of serpentine and masses of silica-carbonate rock form an important part of the Franciscan group and contain the more productive quicksilver mines in the district. Narrow veinlets of chrysotile asbestos commonly cut the serpentine and minute grains of chromite and magnetite are locally abundant. The silicified and carbonatized rocks occur as either hard black massive quartz with associated veinlets of calcite or as buff-colored sugary carbonate closely resembling limestone, containing a few grains of pyroxene pseudomorphs. The soil derived from the Franciscan is generally gray and contains fragments of chert.

Panoche Formation (Upper Cretaceous). Cretaceous sediments exposed on the flanks of Table Mountain consist of concretionary sandstone and shale with coarse conglomerate. The Panoche sediments are dominantly thinly laminated brown or gray shale containing calcareous concretions, features which distinguish them from the sediments of the Franciscan. Interbedded with the shale are prominent ribs of buff sandstone. The soil derived from these Cretaceous rocks is typically buff colored and nearly devoid of rock fragments.

Avenal Sandstone (Eocene). The Avenal formation, a light gray sandstone, overlies unconformably the Cretaceous rocks and forms a narrow band, 300 to 400 feet thick, of prominent ridges parallel to the crest of Reef Ridge. The lower part of the sandstone is generally massive and contains a basal conglomerate; the upper part is more evenly bedded and finer-grained. Oil stains are present in the upper part. The abundant fossil content of the sediments establishes the formation as of marine origin and of Eocene age.

Kreyenhagen Shale (Eocene). Between the rugged ridges displayed by the underlying Avenal sandstone and the overlying Temblor sandstone lies the Kreyenhagen shale. This formation is typically exposed as rounded slopes covered with grass and weeds on the west side of Reef Ridge.

The shales of the Kreyenhagen are typically dark colored, thinly bedded, and generally siliceous. Locally, beds of bentonitic clay and horizons of limestone are exposed. Detailed study of the stratigraphy (Jenkins 1931) and fossil foraminifera (Church 1931, p. 206) has indicated that the sediments of the Kreyenhagen formation were deposited in a sea during upper Eocene time.

Temblor Sandstone (Miocene). The Temblor sandstone rests unconformably on the Kreyenhagen shale and is overlain unconformably by the McLure shale. The Temblor formation forms the conspicuous rugged crest of Reef Ridge. The lower part of the section is a light colored massive sandstone with prominent oil seeps well exposed in Big Tar Canyon. The upper part of the formation is better stratified and contains abundant marine fossils.

McLure Shale (Miocene). The McLure shale member of the Monterey formation is typically hard, platy, and siliceous. Its resistance to erosion permits it to develop prominent ridges which can be easily traced for several miles along its strike. Although the shale weathers to a light color it is generally dark gray on fresh surfaces. A fossiliferous sand and conglomerate lies at base of the formation.

Reef Ridge Shale (Miocene-Pliocene). The Reef Ridge shale is the upper member of the Monterey formation. It differs from the underlying hard siliceous McLure shale principally in its soft silty nature.

Jacalitos Formation (Pliocene). The Jacalitos formation consists of about 3,500 feet of marine sandstone and conglomerate. It crops out as a wide band in the Kreyenhagen Hills and in the Avenal syncline on the west side of Reef Ridge.

Etchegoin Formation (Pliocene). The Etchegoin formation lies conformably on the Jacalitos formation and contains about 1,000 feet of marine conglomerate blue sands, greenish-gray sandstone, silt and clay.

San Joaquin Formation (Pliocene). The San Joaquin formation is similar in lithology to the Etchegoin, but in general appears somewhat finer and contains more clay. It is about 2,000 feet thick in the Reef Ridge area and the fossil contents indicate the sediments are partly marine and partly nonmarine.

Tulare Formation (Pliocene-Pleistocene). The youngest folded strata in Kings County constitute the Tulare formation. These loosely consolidated sediments include about 3,000 feet of sandstone and conglomerate. The abundant fossils are fresh-water species.

Quaternary Alluvium. The late Pleistocene and Recent geologic epochs are represented by a mantle of loose sediments covering the floor of the Great Valley and its larger tributaries. These deposits probably are several hundred feet thick in the larger valleys, but elsewhere the deposits are superficial. They are typically fine grained; many have an earthy appearance and intercalated lenses of sandy gravel. Even in the gradually sloping alluvial fans along the front of the nearby hills, the deposits are largely fine textured, having been derived mainly from soft formations. Over large areas the surface sands and clay are characteristically porous, crumbly, and very soft owing to the thorough removal of moisture from the soil by continued exposure to the warm rays of the sun.

Quaternary Lake Sediments. The flat and well-stratified sediments of the Tulare Lake basin were derived from both igneous and sedimentary rocks. The drainage from the Sierra Nevada on the east introduces abundant quantities of disintegrated granitic material to the lake

Mineral production of Kings County, 1894 [1] to 1950.

Year	Petroleum		Natural gas		Natural gasoline**		Liquefied petroleum gas** (L.P.G.)		Brick		Gypsum		Quicksilver		Misc. and unapportioned	
	Barrels	Value	M cu. ft.	Value	Amount (gals.)	Value	Amount gas.	Value	M	Value	Tons	Value	Flasks	Value	Value	Substance
1894	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
1895	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
1896	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
1897	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
1898	----	----	----	----	----	----	----	----	1,250	$8,450	----	----	----	----	----	
1899	----	----	----	----	----	----	----	----	1,650	11,550	----	----	----	----	----	
1900	----	----	----	----	----	----	----	----	750	5,000	----	----	----	----	----	
1901	----	----	----	----	----	----	----	----	1,000	5,000	----	----	----	----	$10,500	Unapportioned 1900-1909.
1902	----	----	----	----	----	----	----	----	3,500	19,000	----	----	----	----		
1903	----	----	----	----	----	----	----	----	3,400	24,200	----	----	----	----	----	
1904	----	----	----	----	----	----	----	----	3,100	23,300	----	----	----	----	----	
1905	----	----	----	----	----	----	----	----	3,400	24,000	----	----	*250	$9,000	----	
1907	----	----	----	----	----	----	----	----	1,000	8,000	----	----	----	----	1,000	Fullers earth.
1908	----	----	----	----	----	----	----	----	3,000	24,000	100	$400	----	----	1,000	Fullers earth.
1909	----	----	360	$360	----	----	----	----	1,000	8,500	100	300	----	----	2,000	Fullers earth.
															100	Mineral paint.
1910	----	----	1,200	600	----	----	----	----	400	3,200	100	490	100	4,525	1,000	Fullers earth.
															270	Mineral paint.
1911	----	----	1,800	800	----	----	----	----	----	----	20	100	----	----	----	
1912	----	----	6,000	1,650	----	----	----	----	----	----	50	200	----	----	----	
1913	----	----	1,916	575	----	----	----	----	----	----	100	300	----	----	60	Mineral paint.
															400	Other minerals.
1914	----	----	150	500	----	----	----	----	----	----	20	80	----	----	160	Fullers earth.
1915	----	----	258	608	----	----	----	----	----	----	----	----	[2]	----	18,000	Fullers earth, quicksilver.
1916	----	----	258	608	----	----	----	----	----	----	----	----	[2]	----	26,180	Other minerals.
1917	----	----	3,569	2,777	----	----	----	----	----	----	----	----	----	----	----	
1918	----	----	2,460	590	----	----	----	----	----	----	----	----	[2]	----	8,639	Other minerals.
1919	----	----	2,550	1,630	----	----	----	----	----	----	----	----	[2]	----	49,653	Other minerals.
1920	----	----	2,765	1,250	----	----	----	----	----	----	----	----	436	28,620	----	
1921	----	----	2,090	980	----	----	----	----	----	----	----	----	[2]	----	4,742	Other minerals.
1922	----	----	1,790	870	----	----	----	----	----	----	----	----	[2]	----	5,936	Other minerals.
1923	----	----	1,990	970	----	----	----	----	----	----	----	----	----	----	585	Other minerals.
1924	----	----	1,480	725	----	----	----	----	----	----	----	----	----	----	----	
1925	----	----	740	440	----	----	----	----	----	----	----	----	----	----	80	Other minerals.
1926	----	----	470	245	----	----	----	----	----	----	----	----	----	----	475	Other minerals.
1927	----	----	[2]	----	----	----	----	----	----	----	----	----	----	----	1,599	Natural gas and petroleum.

1928	198,784	$576,474													1,240	Miscellaneous stone.
1929	1,968,729	3,294,688	25,809,765	981,343											105	Unapportioned.
1930	6,176,130	9,437,771	47,959,591	3,668,722											350	Unapportioned.
1931	17,607,527	12,735,524	120,253,916	4,636,107											270	Unapportioned.
1932	21,981,835	18,398,796	92,279,724	4,322,190												
1933	21,663,622	20,253,320	104,893,813	5,216,344											4,588	Unapportioned.
															694	Gold.
															3	Silver.
1934	21,393,483	23,104,962	96,939,145	4,957,070											2,560	Miscellaneous stone.
															2,100	Unapportioned.
															83	Gold.
1935	7,167,687	7,490,233	65,372,401	3,088,477										[2]	1,209	Quicksilver, stone.
1936	5,317,882	7,115,273	47,529,901	2,834,058											600	Unapportioned.
1937	5,800,589	8,026,823	45,924,599	2,944,800											964	Unapportioned.
1938	8,717,827	12,117,779	53,242,662	3,290,987											2,118	Unapportioned.
1939	9,871,899	14,115,828	46,054,600	2,536,102									25	2,583	2,930	Stone.
1940	9,212,121	11,625,696	36,016,041	2,018,422									23	3,827	1,500	Stone.
1941	7,789,574	9,479,813	29,639,352	1,818,088											2,166	Unapportioned.
1942	8,906,011	11,131,160	37,266,063	1,821,000											2,960	Unapportioned.
															72,175	Miscellaneous stone.
1943	10,326,575	12,907,422	67,277,904	3,035,350												
															748	Other minerals.
1944	9,459,556	10,689,298	63,648,158	3,294,746												
1945	8,375,249	10,556,594	53,291,804	3,010,740											840	
1946	8,265,449	11,984,901	41,778,881	3,618,803											435	
1947	7,504,000	15,517,000	41,113,000	4,404,000	63,534,000	$3,512,000	36,525,000	$1,317,000								
1948	6,551,000	17,949,000	40,310,000	4,545,000	116,424,000	8,656,000	66,593,000	4,075,000							58,310	Gypsum (crude), sand and gravel.
1949	5,156,000	13,507,000	34,661,000	4,219,000	92,388,000	7,054,000	56,962,000	3,948,000							64,437	Gypsum (crude), sand and gravel.
1950	4,356,000	11,235,000	35,627,000	4,349,000											4,551,973	Gypsum, limestone, natural gasoline L.P.G.
Total	213,767,529	$273,250,355	1,226,921,166	$74,626,527	272,346,000	$19,222,000	160,080,000	$9,340,000	23,450	$164,200	490	$1,870	[2]834	$48,555	$4,907,737	

GRAND TOTAL VALUE = $381,561,244
(Figures re-checked, 1952)

[1] Kings County was created March 22, 1893, from a part of Tulare County, and in 1909 extended by annexing a portion of Fresno County.
[2] See under 'Unapportioned.'
* Flasks of 75 pounds, June, 1904-December, 1927 (inc.); of 76 pounds since.
** Natural gasoline and L.P.G. processed in Kettleman Hills oil field came from gas produced in both Kings and Fresno Counties. Such production is here assigned entirely to Kings Co., because figures by county are not available.

basin while the drainage from the Kettleman Hills on the west contributes reworked sedimentary material. The lake sediments are highly calcareous and shell fragments of fresh-water mollusks are common.

ECONOMIC GEOLOGY AND MINERAL RESOURCES

Petroleum is by far the most important mineral commodity exploited in Kings County, and the world-famous Kettleman Hills oil field ranks among the largest oil fields in California. A more recent discovery of an important oil-producing area in Kings County is the Pyramid Hills field. Numerous exploratory wells are drilled annually in search for additional productive areas.

The mining of gypsite for use in agriculture as a soil conditioner is at present the principal mining activity in Kings County. Quicksilver production, once of significance, has been dormant since World War II.

Because the greater part of Kings County lies in the vast sedimentary basin of the San Joaquin Valley, lode mining in this county is not prominent. The only area likely to contain deposits of metallic minerals is in the Diablo Range in the western part of the county. Here the serpentine and associated ultrabasic rocks have been sheared and mineral solutions are known to have penetrated the rocks. It was from this area that the aforementioned quicksilver production was derived. Chromite float has been found but its source has not been discovered. Magnesite is also known to exist in this area; however, since 1917, when a small amount of magnesite was calcined in the Scott furnace at the Kings quicksilver mine, no production has been recorded.

The grand total value of produced mineral wealth in Kings County during the period 1894 through 1950 amounted to \$381,561,244. During 1950 the value of mineral production amounted to \$20,135,973, of which petroleum and natural gas constituted 77 percent. This placed Kings County in eighth place among California's 58 counties in value of mineral production.

Petroleum and Natural Gas

Kings County oil and gas production comes largely from the world-famous Kettleman Hills. During 1951, approximately 20 million dollars worth of petroleum, natural gas, natural gasoline, and liquefied petroleum gas was produced from this field. The Pyramid Hills field was discovered in 1940, and by January 1, 1952, had produced more than 700,000 barrels of oil.

Wildcatting in Kings County has been continually active since California's frenzied exploration for petroleum began. Many wells were drilled east of Kettleman Hills on Dudley Ridge, which produced a small amount of gas during the thirties. Abundant showings of gas in water wells throughout the Tulare Lake basin attracted drillers to the eastern part of the county and a number of exploratory holes were drilled there. A list of these is included in the tabulation of exploratory holes accompanying this report. One of the first gas fields to be discovered as a result of this activity was the Trico gas field, which extends from Tulare County into Kings County. In 1950, a new producing area was discovered near Hanford, and in the same year Shell Oil Company brought in a gas well at Harvester. Subsequent drilling in these areas has not materially extended the proven acreage. Numerous oil seeps in the Reef

Ridge area have enticed drillers to search for oil in this westernmost extremity of Kings County. Although some of these wells had showings, none of them produced oil in commercial quantities.

Kettleman Hills Field. The Kettleman Hills field lies mainly in Kings County, extending slightly at the north end into Fresno County, and at the south end into Kern County. The hills are about 5 miles wide and extend for about 30 miles in a northwesterly direction on the west side of San Joaquin Valley. The physiographic features and structure of the hills are revealed in a spectacular manner when viewed from the air. The hills stand out of the surrounding plains as a long narrow ridge, barren of vegetation, and the prominent rock formations can easily be traced for miles as they crop out on the flanks of this eroded anticline.

Many wells had been drilled in the Kettleman Hills prior to the discovery of oil by the Milham Exploratory Company in October 1928, but a large number of these were shallow holes of less than 1,000 feet. The discovery well (Elliott No. 1) blew out of control for over a month but was finally completed on November 7, 1928, with a production of 3,670 barrels of 61° gravity oil per day and approximately 80 million cubic feet of gas. The production came from the Miocene Temblor formation between 6,317 and 7,200 feet.

In 1951 the total number of wells in Kettleman Hills field capable of production was 450, of which 332 were actually producing. Total production to June 30, 1951 amounted to 378,138,405 barrels of oil from 13,185 proven acres.

Formations exposed on the surface of Kettleman Hills include the Etchegoin (Pliocene) in the eroded core, and the younger San Joaquin (Pliocene) and Tulare (Plio-Pleistocene) on the flanks. Subsurface formations include Jacalitos (Pliocene), McLure and Reef Ridge (Miocene), Temblor (Miocene), Kreyenhagen and Avenal (Eocene), and Panoche (Cretaceous). The producing horizons are more than 1,500 feet thick and include six zones in the Temblor sandstone (the sixth zone has been provisionally referred to as the Vaqueros) and a seventh zone in what is called the McAdams sand (Eocene).

Structurally the Kettleman Hills consist of a series of three anticlines arranged en echelon, which are known as the North, Middle, and South Domes. North Dome is the largest of the three and produces by far the greatest amount of oil and gas. Although numerous faults occur in the crest of the Kettleman Hills, they die out rapidly downward and none of them extend as deep as the producing horizons. These faults are mainly keystone faults, but transverse faults also occur. The Kettleman Hills appear to be a continuation of the Coalinga anticline to the north and the axis of the fold continues southward toward Lost Hills.

Pyramid Hills Field. The Pyramid Hills oil field is located in the low hills on the east side of McLure Valley in sections 17, 20, and 21, T. 24 S., R. 18 E., M. D. The discovery was made by the Tidewater Associated Oil Company in May 1940 when Well No. 41 was brought in. However, the development of the field did not begin until the completion of the Pacific Oil and Gas Well No. 73 in July 1943. The initial production per well amounts to between 20 and 110 barrels per day of 15.5 gravity crude. The crude has good values in gasoline and lube stocks and sufficient gas

Wells drilled for petroleum and gas in Kings County, to Sept. 1, 1952.

(Exclusive of wells in the Kettleman Hills, Pyramid Hills, and Trico oil fields shown on maps published by State Division of Oil and Gas)

Map number	Location (M.D. B. & M.)			Company and well	Date started	Year completed or abandoned	Depth	Geology*
	T.	R.	Sec.					
1	17S	21E	34	Arthur C. Fisher; Jim 1	3-52	1952	6830	Top Kreyenhagen 6305.
2	17S	22E	33	Texas Co., The; Souza 14-33	6-43	1943	5776	Eocene.
3	18S	19E	1	Shell Oil Co; Fresno Slough Unit 1-1	6-49	1949	8500	Eocene.
4	18S	20E	13	Tide Water Assoc.; Gomes & Silveira 8-13	6-51	1951	8786	Top Kreyenhagen 7945; Domengine 8251; base Capay 8454; bottomed in Cretaceous. (1 ft. oil sand at base of Kreyenhagen).
5	18S	20E	27	Getty, Geo. F.; Grangeville Community 1	10-48	1948	9005	Cretaceous.
6	18S	22E	22	Lake Oil Co.; Blanchard 2	5-51	1951	6500	
7	18S	22E	35	Lake Oil Co.; M.R.M. Phillips 1	10-50	1950	6132	Top continental Miocene 4578; top Kreyenhagen 5940; top Eocene 6030; bottomed in Paleocene (?). Minor showings.
8	18S	22E	36	Goshen Syndicate; Drummond Union 11	5-50	1950	5833	Basal Miocene. Minor showings.
9	18S	22E	36	Goshen Syndicate; Drummond-Union 2	6-50	1950	5404	Discovery well of Hanford area. Flowed 125-150 B/D 20 gravity oil. Producing interval: 5244-5252 from Miocene Zilch zone.
10	18S	22E	36	Goshen Syndicate; Drummond Union 3	8-50	1950	6080	Top Zilch 4600; top Kreyenhagen 5895.
11	18S	22E	36	Arcady Oil Co.; Drummond Union 1	6-51	1951	5362	Poor oil sand 5327-5336.
12	18S	22E	36	Continental Oil Co.; Drummond 2	1-43	1943	5401	Miocene.
13	18S	22E	36	Oilfield Equipment & Supply Co.; Drummond Union 1-5	10-51	1951	5375	Showings not commercial.
14	18S	23E	8	Turner & Goldsberry; Goldurner 1	----	1934	1400	Pliocene ?
15	18S	23E	31	Independent Exploration Co.; Bennett-Smith 52	1-50	1950	6015	Top Santa Margarita equivalent 2973; top McLure 3369; top Kettleman sand 3620; top continental Miocene 4524, Kreyenhagen shale (base Miocene) 5531; Eocene sand (Nortonville?) 5590; top Paleocene (?) 5717; top Cretaceous 5900.
16	19S	19E	17	Shell Oil Co.; Boston Land Co. D	----	1929	3835	Pliocene

17	19S	19E	27	Justice & Ellerby; No. 1	----------	1929	1000	Tulare
18	19S	20E	32	Southern California Petroleum Corp.; Socal-Bergan 88-32	10-44	1944	10478	
19	19S	22E	2	Seaboard Oil Co. of Delaware; Seaboard Continental 66-2	10-43	1943	6633	Eocene.
20	19S	22E	8	Standard Oil Co.; Mills 58-8	4-52	1952	9211	Abandoned.
21	19S	23E	6	Harry S. Sankey; Rockhold 1	5-52	1952	6220	Top Kreyenhagen 5877; base Kreyenhagen 5960. No showings.
22	20S	19E	7	General Petroleum Corp.; B.L.C. 48-7	6-51	1951	14911	No showings.
23	20S	20E	24	California Natural Gas & Development Co.; No. 1	Pre-1925	----------	1290	Tulare.
24	20S	20E	24	Pacific Oil & Gas Co.; No. 2	Pre-1925	----------	1218	Tulare.
25	20S	20E	25	Stone, Glen G.; Teeter 1				
26	20S	20E	25	Stone, Glen G.; Teeter 1	3-37	1940	1303	Pleistocene.
27	20S	22E	21	Harp & Brown; Corcoran Irrigation 1	3-46	1947	3104	Pliocene.
28	20S	22E	25	Western Gulf Oil Co.; C.I.D. 25-1	5-51	1951	8200	
29	21S	18E	24	Pennsylvania Western Oil Co.; No. 1	----------	1931	1338	Tulare.
30	21S	19E	33	Little Chief Oil Co.; No. 1	Pre-1925	----------	4000	Etchegoin.
31	21S	21E	4	General Petroleum Corp.; Richardson 36-4	10-51	1952	12064	Lost fish. Abandoned.
32	21S	21E	7	Monocline Development Co. (Norell, T. G.) No. 1 or Guess 1 ?	----------	1937	6189	Pliocene?
33	21S	21E	7	Guess, E. B. (2) / Monocline Development Co.; (1) } Guess 1	10-27	1937	6189	Pliocene?
34	22S	19E	4	Tide Water Associated; Cohn Est. 6-4	12-39	1940	11885	Miocene.
35	22S	19E	5	Milham Exploration Co.; West Tulare 1	----------	1935	5423	Etchegoin.
36	22S	19E	13	Sunray Oil Corp.; Westlake Farms 1136-13	3-52	1952	5000	Gas showings at 2943-3115.
37	22S	20E	9	Rowan Oil Co.; Crocket & Gambogy 1	9-50	1950	4500	Top 1st Mya zone, 3020; top Cuttler sandstone 3730; base Cuttler sandstone 3750.
38	22S	20E	21	Commonwealth Consolidated Gas, Ltd.; No. 1	----------	----------	----------	Tulare.
39	22S	20E	21	Commonwealth Consolidated Gas, Ltd.; No. 2	----------	----------	2350	Tulare.
40	22S	20E	28	Union Oil Co.; Hancock-Union Giannini 1	----------	1936	5338	Etchegoin.

Map number	Location (M.D. B. & M.) T.	R.	Sec.	Company and well	Date started	Year completed or abandoned	Depth	Geology*
41	22S	20E	28	Shell Oil Co., Inc.; Tulare Lake 21-28	12-42	1943	12491	Eocene.
42	22S	20E	32	Yarrow, Helen; No. 1		1935	1744	Tulare.
43	22S	20E	32	Woodward, Glenn; No. 1		1936	780	Tulare.
44	22S	21E	33	Hancock Oil Co; Crocket Gambogy 23-33	5-50	1950	4000	1st Mya sandstone 2962. No showings.
45	22S	22E	20	Millheim Oil Co.; No. 1		1937	5803	Pliocene.
46	22S	22E	30	Shell Oil Co., Inc.; Salyer 3-1	10-45	1945	3700	Pliocene.
47	23S	16E	2	Shell Oil Co., Inc.; Crow 41-2	12-44	1945	7825	Eocene.
48	23S	16E	10	Kettleman Reef Ridge Oil Co.; No. 1		1932	1110	Miocene ?.
49	23S	16E	10	Shigeki Hiratsuka; 2		1940	1110	
50	23S	16E	10	Chuka Oil Co. (1) Shigeki Hiratsuka (2) } 2A	9-39	1941	1211	Cretaceous ?
51	23S	16E	10	Chuka Oil Co. (2) Kettleman Reef Ridge Oil Co. (1) } 2	1936	1939	285	Miocene.
52	23S	16E	10	Reef Ridge Oil Co.; Well 1	6-51	1951	1803	Oil shows.
53	23S	16E	10	Reef Ridge Oil Co.; Well 2	8-51	1951	1400	At 1300′ 70° dip.
54	23S	16E	11	Easterbrooks, S.F.; 1	4-41	1942	809	Miocene ?.
55	23S	16E	11	Weller, Carl W.; Baby King 2	10-33	1939	1585	Miocene.
56	23S	16E	11	Reef Ridge Prod. (1) Carl W. Weller (2) } Baby King 3	9-35	1938	1048	Miocene.
57	23S	16E	11	Weller, Carl W.; Baby King 2	Pre-1939		1775	Miocene.
58	23S	16E	24	Blair Oil Co.; Blair 1B		1941	2015	Cretaceous.
59	23S	16E	24	Blair, George; No. 1	12-40	1941	985	Miocene ?.

60	23S	17E	5	Birch Ranch & Oil Co.; Orr 1	----------	1937	3112	Miocene.
61	23S	17E	9	Sunray Oil Corp.; Lynch-Mauren 68-9	8-50	1951	11962	Base Jacalitos (top Reef Ridge) 6000; top McLure 6610; Temblor "A" 9310; Temblor "B" 9505; bottomed in lower Zemorrian.
62	23S	17E	9	Barnsdall Oil Co.; Lynch-Mauren 88-9	2-50	1950	9010	Top Miocene 7383; bottomed in McLure shale.
63	23S	17E	18	Big Tar Canyon Oil Co.; No. 1	Pre-1925	----------	1335	Temblor ?.
64	23S	17E	18	Kings Exploration Co.; Avenal 1	11-45	1947	5236	
65	23S	17E	31	British American Oil Producing Co., The; Avenal 86-31	9-45	1945	3435	Cretaceous.
66	23S	17E	35	Associated Oil Co.; Avenal 1	----------	1936	3110	Temblor.
67	23S	17E	35	Associated Oil Co.; Avenal 2	----------	1937	3088	Middle Miocene.
68	23S	17E	35	Whitely & Van Antwerp; No. 1	----------	1922	2100	
69	23S	17E	35	O. M. Slosson; Reserve 1	9-51	1951	538	No shows.
70	23S	17E	35	O. M. Slosson; Reserve 2	11-51	1951	425	Bottomed in gray sand.
71	23S	17E	36	Knudsen & Schmidt; No. 1	----------	1936	6854	Kreyenhagen.
72	23S	18E	30	Harris Investment Corp.; Thunderbird 1	7-51	1951	548	Pliocene.
73	23S	18E	30	S & G Mutual Oil & Gas Development Assn.; Morris 1	4-49	1949	1695	Oil and gas shows on ditch from 1450 to bottom.
74	23S	20E	5	Triume Gas, Oil & Land Co.; No. 1	----------	1935	1103	Tulare.
75	23S	20E	7	California Oil Co.; No. 1	----------	1928	355	
76	23S	20E	7	O'Donnell Gas Co., Ltd.; Dudley Ridge 2	----------	1931	4309	Upper Etchegoin.
77	23S	20E	7	Irma Investment Corp.; Watson 2	11-31	1939	1222	Pleistocene.
78	23S	20E	7	Standard Oil Co.; Wishon-Watson Co. 32	1-52	1952	3350	Abandoned.
79	23S	20E	9	Dudley Dome Oil & Gas Co.; No. 1	----------	----------		
80	23S	20E	9	Dudley Dome Oil & Gas Co.; No. 2	----------	----------	518	Tulare-Recent.
81	23S	20E	13	Pacific Oil & Gas Co.; No. 2	Pre-1925	----------	1800	Tulare.
82	23S	20E	15	Eagle Oil & Gas Co.; No. 1	----------	1933	675	Tulare.
83	23S	20E	15	Eagle Oil & Gas Co.; No. 2	----------	1935	1355	Tulare.
84	23S	20E	20	Valley Exploration Co., Ltd.; Brennan 1	----------	1931	3750	Etchegoin.

Map number	Location (M.D. B. & M.)			Company and well	Date started	Year completed or abandoned	Depth	Geology*
	T.	R.	Sec.					
85	23S	20E	24	Dudley Ridge Development Co.; Josephine 1			1305	Tulare.
86	23S	20E	24	Dudley Ridge Development Co.; Josephine 2		1938	6498	Jacalitos.
87	23S	20E	28	Standard Oil Co.; Mackroth 1	11-50	1950	4596	Etchegoin. Tests unsuccessful.
88	23S	20E	34	Graphic Oil Corp.; Taylor 1	8-39	1939	4044	Pliocene.
89	23S	21E	2	Magee, Harry H., operator; Von Glahn 2-1	5-45	1945	5005	Pliocene.
90	23S	21E	8	Western Gulf Oil Co.; 14-8 Von Glahn	5-46	1946	4841	Pliocene.
91	23S	21E	11	Shell Oil Co.; Harvester Unit 1-1	2-50	1950	4300	Discovery well of Harvester area. Initial production 4150 MCF gas per day from San Joaquin formation.
92	23S	21E	13	Shell Oil Co.; Mortgage Service Co. 1	4-50	1950	3758	Recovered gas on test. Bottomed in Pliocene.
93	23S	21E	18	Pacific Oil & Gas Co.; No. 1	Pre-1925		2715	Etchegoin.
94	23S	21E	25	Standard Oil Co. of California; Mortgage Guarantee Community 1	12-44	1945	4793	Pliocene.
95	23S	22E	4	Von Glahn, Elmer C.; Elmer C Von Glahn 1	6-42	1942	9731	Miocene.
96	23S	22E	4	Kings County Oil Co. (2) / Elmer C. Von Glahn (1); Elmer C. Von Glahn 1	6-42	1948	13213	Eocene.
97	23S	22E	10	Tri-Counties Oil Co.; Olson 1	4-37	1947	7765	Upper Miocene.
98	23S	22E	10	Tri-Counties Oil Co.; Olson 1			4300	Tulare.
99	23S	22E	12	California Natural Gas & Development Co. No. 1	Pre-1925		2076	Tulare.
100	23S	22E	12	California Natural Gas & Development Co. No. 2	Pre-1925		2255	Tulare.
101	23S	22E	12	California Natural Gas & Development Co. No. 3	Pre-1925		4040	Etchegoin.
102	23S	22E	12	California Natural Gas & Development Co. No. 4	Pre-1925		1831	Tulare.
103	23S	22E	12	Dudley Petroleum Co. (B.B. & E.R.) No. 1	Pre-1925		1780	Tulare.

104	23S	22E	12	Guess, E. B.; Guess 2	----------	1932	2208	Tulare.
105	23S	22E	13	Sunray Oil Corp.; Mary Ann Richardson 1	9-47	1947	3800	Pliocene.
106	23S	22E	17	Magee, Harry H., operator; Von Glahn 17-1	4-45	1945	4104	Pliocene.
107	23S	22E	29	Standard Oil Co. of California; Cutter 2	11-45	1945	4560	Pliocene.
108	23S	22E	29	Standard Oil Co.; Cutter Unit 3	11-51	1951	3750	
109	23S	22E	30	Standard Oil Co. of California; Hughes 1	10-48	1948	3740	Pliocene.
110	23S	22E	34	Standard Oil Co. of California; Von Glahn Unit 1	6-44	1944	4624	Pliocene.
111	24S	17E	9	Welport Oil Co.; Avenal 1	----------	1932	3940	Cretaceous.
112	24S	17E	13	Dial, Glen; Miller 1	10-46	1946	2385	Upper Miocene.
113	24S	17E	22	Miesse, Richard S.; Jackie 1	4-42	1942	502	Cretaceous.
114	24S	17E	25	Chanslor-Canfield Midway Oil Co.; Orchard 1	7-47	1947	2503	Cretaceous.
115	24S	18E	8	Richardson, Guy; Holtz & Zennetti 1	8-46	1947	1640	Upper Miocene.
116	24S	18E	8	Fiske, J. H.-H. G. Spengler, Trustee and Henry R. Dabney; Core Hole F.S.D. 2	11-45	1945	1036	Pliocene?.
117	24S	18E	8	Dohm Oil Co.; Fairco 1	10-51	1951	868	
118	24S	18E	8	T. M. Pope; Eagle 1	4-51	1951	1850	
119	24S	18E	14	Alva McPhaill & Roy Gill; McPhaill 1	8-51	1951	5099	Top *Scalez* zone 4615; Etchegoin 4810.
120	24S	18E	16	Royalty Service Corp., Ltd.; Spreckels 1	----------	1936	4201	Miocene.
121	24S	18E	16	Pyramid Production Co.; Spreckels 2	6-41	1941	1861	Middle Miocene.
122	24S	18E	19	Glen H. Mitchell & Mitchell Co.; Mitchell-Lucier 1	8-51	1951	1803	Minor showings. Fault at 1500±.
123	24S	18E	19	Barnes Core Drilling Co.; Lucier 2	9-51	----------	----------	Top McLure 7550; thrust fault at 2100.
124	24S	18E	27	Pyramid Production Co.; Retherford 1	10-37	1940	3088	Eocene (?).
125	24S	18E	28	Pacific Oil & Gas Development Corp.; Hand 35-28	12-49	1949	2600	Temblor 687; Kreyenhagen 950; Upper West Slope sand 1168; Point of Rocks sand 1523; upper Canoas 2150; lower Canoas 2212; Domengine 2340; Cretaceous 2364; hard brown shale 2393-2600. Oil shows.
126	24S	18E	28	Pacific Oil & Gas Development Corp.; Sharp 76-28	1-50	1950	2573	Top Temblor 635; Kreyenhagen 2374; gray sand 2540.
127	24S	18E	28	Norris Oil Co.; Well 1	4-51	1951	1384	Top Kreyenhagen 905.
128	24S	18E	28	Norris Oil Co.; Well 18-28	7-52	----------	934	Abandoned. No cores taken.
129	24S	18E	28	Norris Oil Co.; Well 116-28	7-52	1952	1022	Basal McLure 867-896; Kreyenhagen-1 sand 989.

Map number	Location (M.D. B. & M.)			Company and well	Date started	Year completed or abandoned	Depth	Geology*
	T.	R.	Sec.					
130	24S	18E	28	Norris Oil Co.; Well 114-28	7-52	1952	884	McLure 847-877.
131	24S	18E	28	Norris Oil Co.; Well 115-28	6-51	1951	893	Discovery well of Pyramid Hills-South. Initial production 40 B/D 14 gravity oil. Producing interval 852-892 from basal McLure.
132	24S	18E	28	Nelson B. Cramer; Dotty 1	10-51	1951	1000	
133	24S	18E	29	Buaas Development Co.; Deming 1	2-47	1947	3103	Upper Eocene.
134	24S	18E	29	Norris Oil Co.; Hand 2	1-52	1952	841	Top Kreyenhagen sand 793—gray.
135	24S	18E	29	Norris Oil Co.; Hand 1	9-51	1951	3008	Top Kreyenhagen 760; Eocene sand 774; base Eocene sand 1202; thrust fault 2180; McLure 2535-2555.
136	24S	18E	30	Tide Water Associated Oil Co,; Orchard 56	5-43	1943	3039	Eocene.
137	24S	18E	34	General Petroleum Corp.; McRae 1		1921	3045	Kreyenhagen
138	24S	18E	34	Standard Oil Co.; Kettleman 1	Pre-1925		6602	McLure.
139	24S	19E	35	South Dome Oil Co.; Clarence G. Smith 1			2913	Etchegoin.
140	24S	19E	35	South Coalinga Oil Co. (1) South Dome Oil Co. (2) } Clarence G. Smith 1	12-25	1942	3110	Pliocene.
141	24S	20E	11	Bisconer, Raymond (1) Dudley-Kettleman Gas & Oil Co. (2) }	5-37	1942	2550	Pleistocene.
142	24S	20E	11	Bisconer, Raymond; No. 1			2496	Tulare.
143	24S	20E	12	Shell Oil Co., Inc.; La Hacienda 1	11-48	1948	5015	Pliocene.
144	24S	21E	19	Shell Oil Co.; No. 2	Pre-1925		1187	Tulare.
145	24S	21E	22	Shell Oil Co.; No. 1	Pre-1925		1141	Tulare.
146	24S	22E	33	Magee & Stone; No. 2		1934	3082	Etchegoin.
147	24S	22E	33	Trico Oil & Gas Co.; No. 1		1934	3811	Etchegoin.
148	24S	22E	34	Magee & Stone; No. 1		1933	5215	Etchegoin.

* Unless otherwise stated, the formation or age indicated refers to the rocks found at the bottom of the hole.

is produced to fire boilers for treating the oil. In January 1952, there were 21 producing wells and the cumulative production of the field to that time was 717,336 barrels.

The only formation exposed on the surface at the Pyramid Hills field is the McLure shale. Subsurface formations include the middle Miocene Temblor shale and the Eocene Kreyenhagen and Domengene (Avenal sandstone) formations. The deepest wells bottom in Cretaceous shales. Production is obtained from the basal McLure, the Temblor sandstone, and the Kreyenhagen formation.

The principal structural feature of the Pyramid Hills field is a northwest-trending anticlinal fold. Following deposition of the Eocene strata and subsequent folding, the area was uplifted and strongly eroded. After this erosion, Miocene seas encroached upon the area and sediments were deposited with strong angular unconformity upon the Eocene beds.

Dudley Ridge Area. The first well was drilled in the Dudley Ridge area in 1920. Showings of wet gas with ethane and gasoline were reported. Several other wells were drilled in the years following, but caving sand hampered drilling and production. For details about these early wells, see Henny (1943).

In 1929, when the Dudley Ridge Syndicate well No. 1 was drilled, gas was encountered at 1,142 feet and the well blew out. After flowing for two weeks, it was brought under control and delivered some three million cubic feet of gas per day to Kettleman City and to neighboring drilling wells for about 2 years. Mud later appeared in the well and it was abandoned. The gas-producing wells of Dudley Ridge were all low pressure wells, and were abandoned when it was no longer economic to compete with the high-pressure gas wells of Kettleman Hills.

Gerard Henny (1943, p. 539) describes the distinguishing features of the field as follows:

> "Wells in the western part of the field (Sec. 2, 11, 12, T. 23 S., R. 19 E., and Sec. 7, T. 23 S., R. 20 E., M. D.) produced gas that is almost pure marsh gas. It came from a 6-foot horizontal sand at a depth of 1,200 feet. To the east, the gas comes from different levels—the Eagle Oil and Gas Company's well blew out at 675 feet, and the Pacific Oil and Gas Company's well had gas at depths of 1,610 and 2,085 feet. The gas from this last well had an important gasoline content."

The Dudley Ridge area is entirely covered by alluvium, for it lies wholly inside the borders of the vast San Joaquin Valley, but surprisingly enough the thickness of the alluvium is only a few hundred feet. A drill core taken at 550 feet in the Dudley Syndicate well was reported to be Tulare (Pleistocene). The Tulare formation, 3,000 to 3,500 feet thick, rests upon approximately 2,000 feet of the San Joaquin formation, which is underlain by about 4,500 feet of Etchegoin formation. None of the wells in the Dudley Ridge area have penetrated Miocene strata.

The first wells in the area were drilled in the vicinity of the topographic rise known as Dudley Ridge. It was assumed that this ridge was an anticline, but later work showed that it originated as sand dunes on the margins of Tulare Lake (Henny 1943, p. 541). West of the ridge, however, is a series of shallow depressions trending in a northwesterly direction that has been interpreted by some geologists as a possible fault. The accumulation of gas just north of this zone could be a result of this con-

jectural fault barrier. The wells farther to the east may be on a buried anticlinal structure.

Hanford Area. In July 1950, the Goshen Syndicate brought in a producing well east of Hanford in sec. 36, T. 18 S., R. 22 E., M. D. This well, the "Drummond Union" 2, had an initial production of 125 to 150 barrels per day of 20.2 gravity oil. The producing interval is in the Miocene "Zilch" zone at 5,244-5,252 feet. The cumulative production to June 30, 1951 was reported by the State Division of Oil and Gas to be 3,582 barrels.

A number of wells have been drilled in the Hanford area since the discovery well was brought in, but none has proved to be commercial. Some of the wells have been very deep tests. One of the deepest was Standard Oil Company's "Mills" 58-8 which was abandoned at 9,211 feet. A summary of the test wells drilled in the Hanford area may be found in the tabulated list of exploratory wells accompaning this report.

Gypsite

The gypsite mined in Kings County is an impure variety of gypsum consisting of an earthy mixture of gypsum, sand, and clay. Gypsite forms only in regions of little rainfall and rapid evaporation. The gypsite deposits in Kings County probably developed along the moist margins of a recurrent lake when a powdery crust of calcium sulfate particles was deposited on the surface by rising solutions.

The deposits are mined by open-pit methods, using carryall scrapers. Truck-loading chutes are constructed and the material is loaded into trucks for transport directly to the farmer's fields. The operation of these low-grade gypsum deposits is quite profitable, because neither beneficiation nor sacking of the gypsite is required, the method of mining is inexpensive, and the San Joaquin Valley farms which use the gypsite are nearby.

The gypsum is used in agriculture for improving the soil. It increases permeability, improves the texture, reduces severe clod and crust formation, renders the soil easier to work, and aids in the reclamation of alkali soils. Gypsum reacts with the sodium carbonate ("black alkali") in the soil to form sodium sulphate and calcium carbonate. This is a distinct advantage because sodium sulphate is much less injurious to plant life than sodium carbonate.

Avenal Gap Mine. The Avenal Gap mine is located in secs. 2, 3, and 11, T. 24 S., R. 18 E., M. D., about 10 miles south of Avenal in Kettleman Plain, 1.5 miles east of Highway 33. It is owned by H. M. Holloway, Box 310, Lost Hills.

Mining commenced at this location in 1947 and has been continued to date. The flat gypsite body lies with a sharp but irregular contact on sandy clay. It is elongate in shape and trends in a northwesterly direction paralleling a series of gentle swells or rises in the topography. Two to 3 feet of sandy soil overburden generally overlies the main gypsite body. The average thickness of the gypsite bed is about 6 feet. The overburden is stripped with carryalls and the gypsite loaded directly into trucks, wetted down with water and hauled to agricultural areas. In the summer of 1952 this material was sold for $1.50 per ton at the mine.

McPhaill Gypsum Company. The McPhaill Gypsum Company deposit is located in sec. 14, T. 24 S., R. 18 E., M. D., and is owned by Alva McPhaill, 1001 North Willis Street, Visalia, California.

The deposit is a southern extension of the Holloway (Avenal Gap) gypsite mine described above. When the site was visited in the summer of 1952, stripping of the thin layer of loose soil overburden from the gypsite body had just been started. One carryall and a scraper were engaged in this operation.

Quicksilver

The Kings County quicksilver mines are located in Franciscan and Panoche rocks at the extreme westernmost tip of the county in the area known as Table Mountain. Parkfield, in Monterey County, is the closest town. The unimproved road from Parkfield to the mines, however, is steep, rough, and impassable in winter. Even in summer it is generally unsuitable for cars without four-wheel drive. The mines are more easily reached by a circuitous southern route via McLure Valley and Avenal Canyon.

Table Mountain is principally serpentine. Franciscan sandstone or shale and Cretaceous sedimentary rocks make up the rest of the area. Most of the ore bodies occur in serpentine or in masses of silicified and carbonatized sheared serpentine known as silica-carbonate rock. The recognition of this type of rock is therefore of great importance in prospecting for ore. Silica-carbonate rock is found in bedrock near faults bounding masses of serpentine, and some occurs in landslides extending below serpentine outcrops. A lesser amount of ore is found as replacements in sandstone beneath overthrust serpentine. The principal ore minerals are bright red cinnabar and native mercury.

During 1941 the U. S. Geological Survey (Bailey 1942) made an investigation of the Table Mountain quicksilver mines and reported:

". . . the known reserves of mineable ore can be expected to yield only a few hundred flasks of quicksilver, but the chances of finding new ore are fairly good."

Their suggestions for prospecting are stated as follows:

"The Table Mountain area has not been thoroughly prospected, and there are several places where new ore bodies of small size might be found. Between the White mine and the Dawson mine is a fairly continuous zone of scattered outcrops of silica-carbonate rock, which are doubtless boulders forming part of a landslide that consists mainly of serpentine. The Dawson mine has yielded more than 1,000 flasks of quicksilver from an area containing an extraordinary number of such blocks, which have slid, without becoming widely separated, from a ledge that probably cannot be found and may have been eroded away. However, other areas along the zone between the White and Dawson mines should be carefully prospected. One boulder of good ore in this zone cannot be considered an ore body; but there may be spots where a number of blocks have kept together in sliding and would constitute a workable ore body similar to that of the Dawson mine."

Kings Mine. The Kings mine, located in sec. 20, T. 23 S., R. 16 E., M. D., was first operated extensively by the Kings Quicksilver Mining Company, Ltd., a Canadian firm. A 10-ton Scott furnace was erected in 1914 and operated until the close of 1916; it was later demolished and no evidence of it is visible today. The greatest output was in the period 1914-16, during which 480 flakes of quicksilver were produced. During World War II, the mine was owned by L. K. Anderson and leased to Bert Harvey. From 1905-45 the cumulative production amounted to 1,041 flasks. When the area was visited in the summer of 1952, H. Twisselman of San Miguel had acquired the mine, which was idle.

Kings County mineral deposits

Map number	Claim, Mine, or Group	Owner Name, Address	Location Sec.	Location T.	Location R.	Location B & M	Remarks
			Brick				
	Clinker Brick Co.	J. H. Burnett, Hanford					1.5 miles south of Hanford. Abandoned prior to 1911. R14:527; R17:76.
	Adell Cartright Co.	A. D. MacDougall, Hanford					Also concrete pipe, cement. Plant in Hanford, now abandoned. R26:422
			Fullers Earth				
149		Edward A. Webb & S. M. Mingus	26	21S	17E	MD	No reported production. R26:415
			Gypsite				
150	Avenal Gap	H. M. Holloway, Inc., Box 310, Lost Hills	2 3 11	24S	18E	MD	Active operation. R47:331; B163:56; herein.
151	McPhaill Gypsum Co.	Alva McPhaill, 1001 N. Willis St., Visalia, Cal.	14	24S	18E	MD	Commenced operation 8-1952. Herein.
152	Tulare Lake View group	Louis and Oscar Couch, R. E. Stevens, et al. Hanford	26, 35 36	21S	17E	MD	Also fullers earth. No reported production. R14:527.
153		C. E. Boyd, Hanford	13	24S	17E	MD	Also fullers earth. Small production reported in 1913. R14:527; R17:76
			Magnesite				
154		Kings Magnesite Company, Adelsbach and Smith, Parkfield (1925)	20	23S	16E	MD	No production since 1917. B29:51
			Quicksilver				
155	Fredanna (Kings)	Ida Twisselman, San Miguel	20	23S	16E	MD	Last production in 1946. R14:529; R35:383; USGS, B178:51, 338; USGS, B936-F:143-169
156	Dawson	Jack Ellena	28	23S	16E	MD	Inactive since World War II. R14:528; R17:77; R35:382; B29:122; USGS, B936-F:143-169
157	Fairview and French Avalloch group	G. H. French and J. A. Greenlaw, Parkfield (1920)	28	23S	16E	MD	Assessment work only. No recorded production. R14:529; R17:77
158	Canyon	L. Tate, C. F. Francis, P. Peterson, operators in 1939. H. A. Whitley, Hearst Bldg., San Francisco, administrator	22	23S	16E	MD	Small production in 1937-1939
			Sand				
		N. M. Wilkerson					Pit located about 1.5 miles W. of Hanford. Now abandoned. R26:423

The Kings mine is in a landslide area, and outcrops are scarce. For this reason structural control of the ore is not apparent. Edgar Bailey (1942, p. 165) describes the reserves of the mine as follows:

"Because of the caved workings and the scarce outcrops, it is impossible to make any accurate estimate of the reserves of the mine. On the 50-foot level of the old shaft, the base of an ore body, said to have been 70 feet long and 28 feet high, is exposed in a tunnel driven in under the old stope now filled with waste. A foot-wide mineralized zone in sheared serpentine, said to assay more than 100 pounds of quicksilver to the ton, is exposed in this adit, but it cannot be mined because of the unsafe burden. In the new lower adit, native mercury and cinnabar occur in crushed sandstone of the Franciscan formation, and to a lesser extent in shale. Single specimens averaging better than 20 pounds of quicksilver to the ton can be easily obtained, but no continuous bodies of ore have yet been developed. The western extension of the adit is in essentially barren serpentine."

Dawson Mine. The Dawson quicksilver mine is in sec. 28, T. 23 S., R. 16 E., M. D., in a large landslide which extends from near the top of Table Mountain to Avenal Canyon, a distance of nearly 2 miles. The first recorded production was in 1918; from 1918-22 there were 1,030 flasks of quicksilver produced. During World War II the mine, then owned by Jack Ellena, was leased by C. C. Jones and W. E. Kearns.

Mining has been concentrated in a shallow glory hole and in several hundred feet of workings beneath the pit. Edgar Bailey concludes from his investigation of the Dawson mine that:

". . . unless other large bodies of ore are discovered nearby in the landslide, no further production from the mine can be expected."

Sand and Gravel

Early reports of the State Division of Mines (Boalich 1921, p. 77; Franke 1930, pp. 422-423) described a few sand deposits in the vicinity of Hanford which contained material suitable for concrete. However, only a small amount of this material has ever been mined, for the farmers are generally reluctant to have their land defaced with deep pits, thus reducing its value as farm land. The bed of the Kings River and the beds of other river extensions of the Sierran drainage contain material which generally is not clean and which is too fine and silty to be useful. The extreme fineness of the sediments is a result of the extremely low gradient of the streams as they encroach upon the central part of the valley floor; here the competence of the stream allows it to transport only the finest material.

In recent years most of the sand and gravel utilized for construction purposes have been brought into Kings County from Fresno County.

Crushed Rock

Crushed rock suitable for road metal has been obtained largely from the hard, dense siliceous shale which crops out in the western part of the county. In Big Tar Canyon, and also on Highway 41 where it crosses Pyramid Hills, crushed rock has been excavated from the McLure shale.

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ADSORBENT CLAYS IN CALIFORNIA

By Richard S. Lamar*

OUTLINE OF REPORT

Illustrations

ABSTRACT

Adsorbent clays, first produced in California in 1899, are now widely used for the decolorization and purification of fats and oils. The petroleum industry is by far the largest consumer of adsorbent clays. California is now an important source of fuller's earth (clay that possesses natural decolorizing properties) and activated clays (manu-

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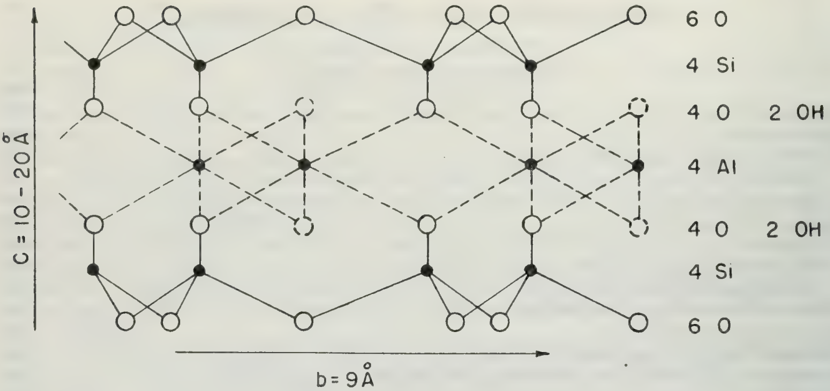


FIGURE 1. Idealized molecular structure of montmorillonite as projected on a plane. *After Hofmann, Endell and Wilm, 1933.*

factured by the acid-leaching of bentonite). The activated clays possess several times the decolorizing efficiency of fuller's earth and are more economical and preferred for this reason in spite of their greater cost per pound.

Clays vary widely in their natural decolorizing efficiency and in their response to various methods of activation. Activation is generally accomplished by partial acid leaching of the clay mineral, a process which selectively removes a portion of the crystal structure and develops a high porosity. Activation is also accomplished by a partial dehydration of the clay mineral at elevated temperatures. This method also develops a porous structure and increases the surface area of the clay.

The adsorbent clay industry is continuing to expand in California where large deposits of suitable raw clays and ample supplies of sulfuric acid used in activating the clays are available.

INTRODUCTION

The oil industries employ various clay-rich materials which, either in their natural state or after chemical or physical treatment known as activation, have the capacity to adsorb coloring matter and other impurities selectively from oils. All of the materials probably contain one or more members of the montmorillonite group of clay minerals, including the minerals montmorillonite ($(Mg,Ca)O \cdot Al_2O_3 \cdot 5SiO_2 \cdot nH_2O$), beidellite ($Al_2O_3 \cdot 3SiO_2 \cdot nH_2O$), nontronite ($(Al,Fe)_2O_3 \cdot 3SiO_2 \cdot nH_2O$) and saponite ($2MgO \cdot 3SiO_2 \cdot nH_2O$). The clay mineral kaolinite ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) does not possess this property of color adsorption either in the natural state or after any known method of activation. Fuller's earths, the naturally active clays, are prepared from bentonite possessing innate color adsorbing powers. Such materials usually are not activated commercially. In fact, most fuller's earths do not respond to further activation by acid treatment or leaching, the commonly used methods, but are prepared either as a fine powder for use in the contact method of decolorizing oils or as closely sized granular products for use in the percolation method of oil treatment.

Bauxite ($Al_2O_3(H_2O).$), which in the natural state possesses practically no decolorizing efficiency, can be activated by heat treatment and is used extensively to decolorize petroleum oils by the percolation process. Bauxite, however, is not a clay mineral in the strict sense.

The activated clays, sometimes called acid-leached or acid-treated clays, are also prepared from bentonite. Clay whose decolorizing power is affected by acid treatment shows little if any such power when raw.

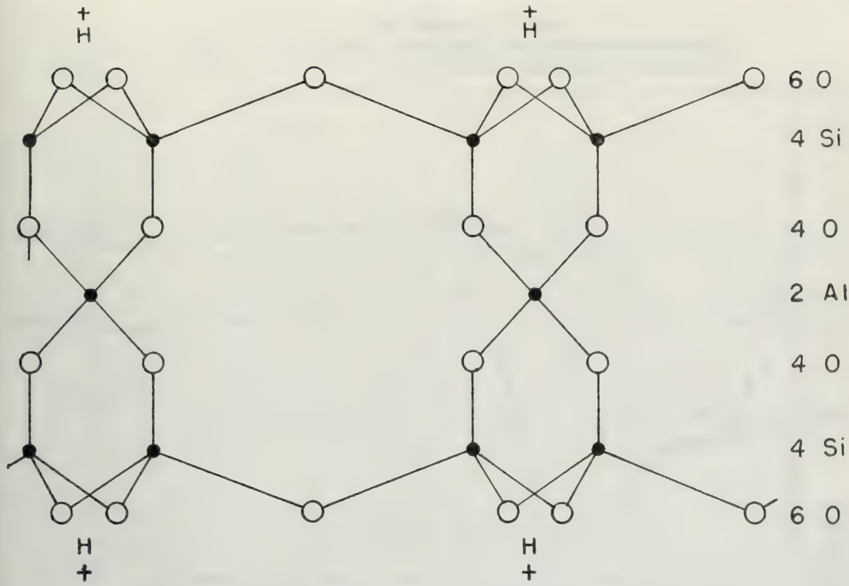


FIGURE 2. Idealized molecular structure of activated clay prepared by acid-leaching. One-half of the central layer of aluminum has been removed leaving a negative charge on the crystal lattice. A hydrogen ion becomes associated with the lattice to neutralize this charge. *After Thomas, Hickey, and Stecker, 1950.*

Activated clays usually possess several times the decolorizing efficiency of fuller's earth. For this reason, in spite of their greater cost, they have in many uses replaced fuller's earth. The manufacture of activated clays has been developed extensively in the western part of the United States, especially in California, where there are large deposits of suitable raw clay and sources of inexpensive sulfuric acid. The activated clays are ordinarily prepared as a powdered material only for use in the contact method of decolorizing oils.

Adsorbent clays used by the oil industries are prepared for two methods of use: percolation and contact. The percolation type clays are marketed in the form of closely sized granules. In use the granules are packed into columns through which the oil is allowed to percolate. Contact clays are marketed in the form of a fine powder (90 percent through 100 mesh and finer). The clay is added directly to the oil and agitated, followed by filtration.

With both types, decolorization is obtained by effecting an intimate contact between the oil and clay at an elevated temperature. The granular, percolation grades of clay are revivified by washing with solvents and burning to remove the adsorbed material. The contact clays are seldom if ever reclaimed and are usually discarded after a single use. Percolation and contact clays are used extensively by the petroleum industry while the fatty oil industry uses only the contact grades.

The use of fuller's earth by the oil industry is nearly as old as the oil industry itself. Rich (1949) states that the Chinese used it for decolorizing more than 1000 years ago. Mention of it is made in the Bible and in the writings of Pliny. Fuller's earth was first mined in England in the middle of the 19th century; in 1880 the first commercial shipments were made to this country.

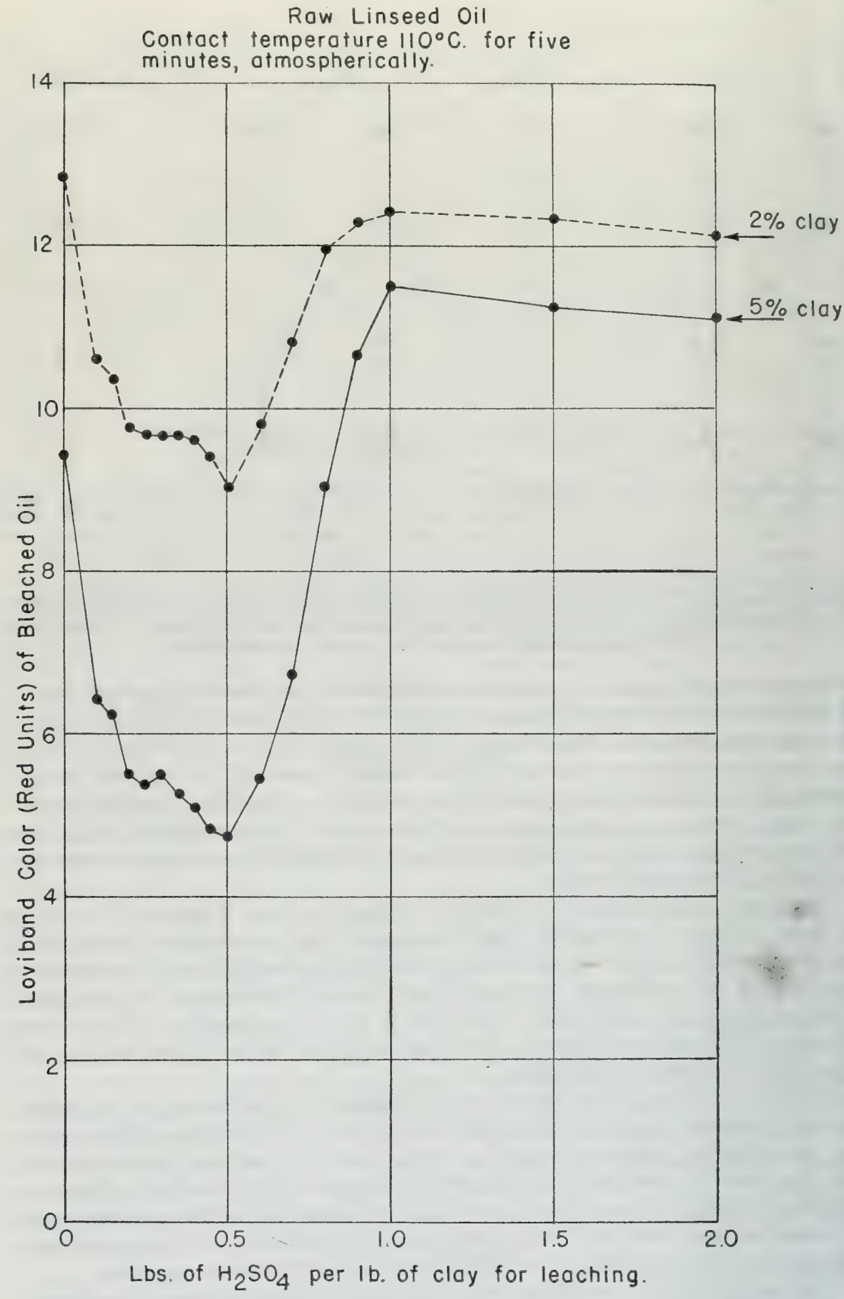


FIGURE 3. Graph showing changes in decolorizing efficiency of Olancha fuller's earth, as tested with raw linseed oil, as increasing amounts of sulfuric acid are used to leach the clay. The figure shows that maximum efficiency is obtained by using approximately 0.5 pounds of acid per pound of anhydrous clay. Lower Lovibond red units indicate lighter colored oils.

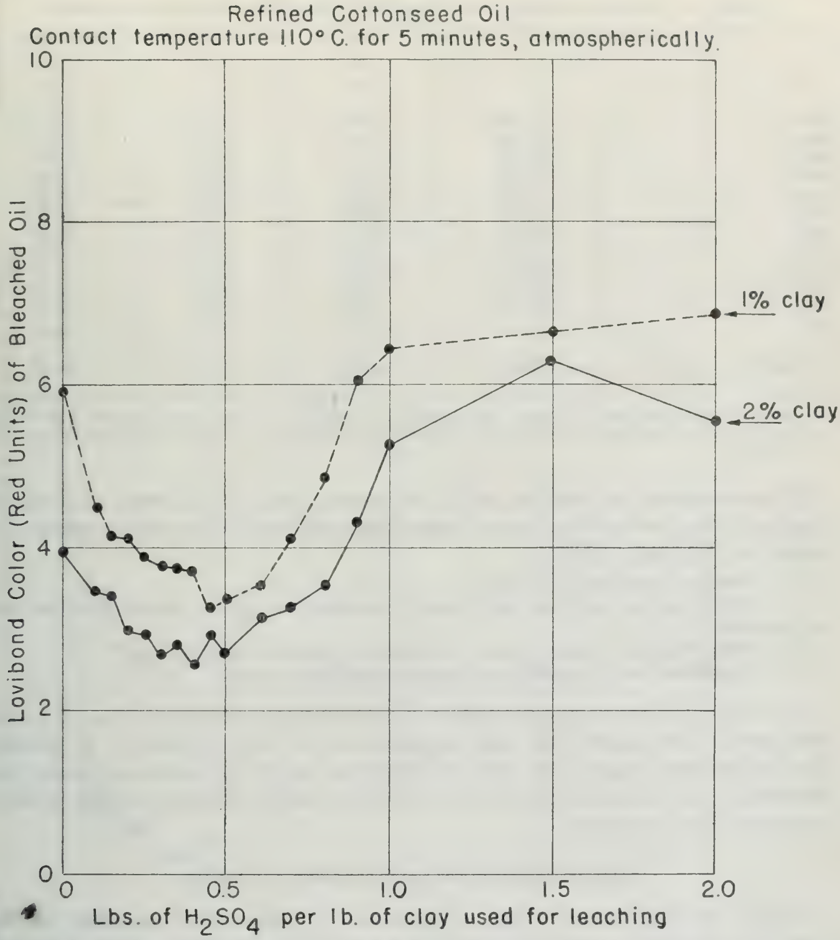


FIGURE 4. Graph showing changes in decolorizing efficiency of Olancha fuller's earth, tested with refined cotton seed oil, as increasing amounts of sulfuric acid are used to leach the clay. Maximum efficiency for color removal, when tested with this oil, is obtained using from 0.35 to 0.50 pounds of acid per pound of anhydrous clay.

In 1891 a deposit of commercial importance was discovered in Arkansas and a few years later extensive deposits in Georgia and Florida were found. Subsequently deposits have been found in California and other states. Acid activation of clays was started in Germany in about 1905 and increased rapidly during the first World War when importations of fuller's earth from England were cut off. Acid activation of clays was started in the United States also during the first World War. Since that time the industry has grown tremendously with the rapidly expanding oil industries.

Because large quantities of various types of oil (petroleum, vegetable, animal, and marine or fish oils) are produced in California, large amounts of adsorbent clays are needed. Although much of the clay produced in California is used within the state by these various industries large quantities are also shipped to other states and indeed practically all over the world to be used in similar applications.

Table 1. Chemical analyses of absorbent clays from California deposits.[1]

	A	B	C	D
H_2O-	9.33%	10.11%	11.93%	14.77%
H_2O+	5.74	6.80	5.27	6.73
SiO_2	58.63	61.50	45.62	56.70
Al_2O_3	12.76	14.37	8.43	14.23
Fe_2O_3	5.92	1.36	0.57	2.83
TiO_2	0.47	0.08	0.19	0.32
MnO	0.03	trace	trace	0.03
CaO	1.21	0.15	3.14	0.75
MgO	3.39	4.26	21.89	2.38
Na_2O	0.91	0.62	0.72	0.22
K_2O	1.65	0.42	0.67	0.14
CO_2	----	0.19	3.30	none
Total	100.04	99.86	101.73	99.10

[1] A.—Fuller's earth from Olancha deposit, Inyo County. B.—Fuller's earth from Muroc deposit, Kern County. C.—Saponite clay occurring near Death Valley Junction, Inyo County. D.—Acid activated clay, source undetermined.

The petroleum industries, which consume about 90 percent of the total production of adsorbent clays, use these materials in many ways; for example (Mantell, 1951):

(1) Catalytic cracking of gasoline.

(2) Decolorization and removal of gums from gasoline and the lighter fractions such as kerosene.

(3) Decolorization and removal of acid sludges from lubricating oils.

(4) Decolorization of paraffin and micro-crystalline waxes.

In 1951 California was exceeded only by Texas in the volume of cotton produced. Cottonseed oil, one by-product of this industry, is refined, decolorized and made into such products as salad oil, oleomargarine, and shortening, by companies within the state using California-made adsorbent clays in the process.

PROPERTIES OF ADSORBENT CLAYS

Field Identification. The appearance of clay-rich material, as observed in the field, cannot be used as a reliable indication of its decolorizing efficiency or adsorptive capacity, but certain features are useful in tentative identification. When mined, most adsorptive clays contain over 50 percent free moisture, have a soapy, greasy texture and can be cut with a knife like a fresh cake of laundry soap. A shaving will exhibit a soap-like translucency which is more pronounced in the activable bentonites than in the naturally active fuller's earths.

Adsorbent clays range in color from all shades of green and red to white and black. Color is not a satisfactory criterion for determining their value as adsorbents. Some dark colored clay is more efficient as a decolorizer than pure white clay.

When dried, lumps of fuller's earth show a strong tendency to stick to the tongue. The activable clays do not show this tendency so strongly. Fuller's earth will neither slake nor swell in water. Activable bentonites will slake in water, forming chip-shaped granules, but do not swell to any appreciable extent. Adsorbent clays are noticeably less dense than kaolin and other sedimentary clays, the fuller's earth being even less dense than the activable clays.

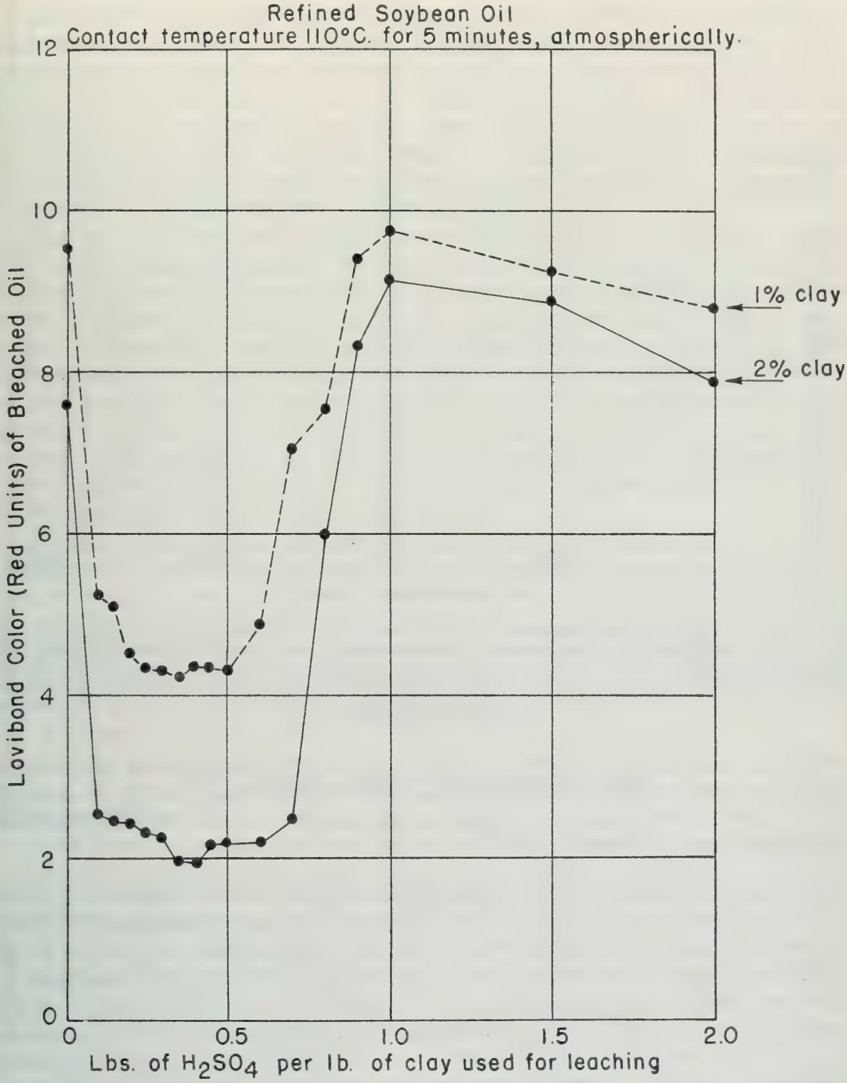


FIGURE 5. Graph showing improvement in decolorizing efficiency of Olancha clay after acid leaching as tested with refined soybean oil. Maximum activity or decolorizing efficiency is obtained using 0.35 to 0.50 lbs. of acid per lb. of clay.

Chemical Composition and Properties. The chemical compositions of several clays produced in California are shown in table 1. Adsorbent clays have an alumina-silica ratio of 1:2 to 1:8, differing from clays of the kaolin type which show a lower proportion of silica. A high ratio is sometimes indicative of good adsorptive capacity. Some fuller's earths show a high apparent acidity in water requiring from 10 to 150 cc. of N/10 NaOH per 100 grams clay for neutralization. Other clays have good color adsorption properties but do not exhibit an apparent acidity. All fuller's earths and activable bentonites exhibit base exchange capacity. This as well as other fundamental properties of clays is cov-

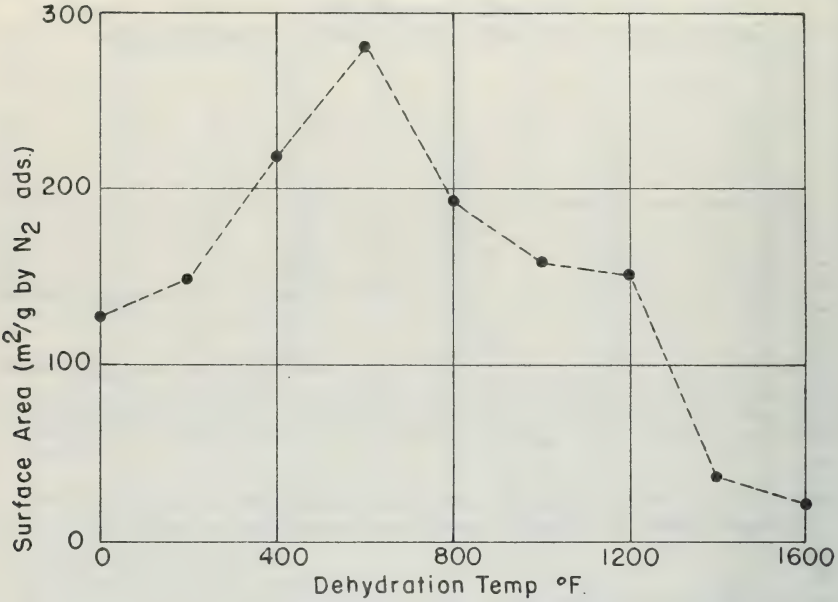


FIGURE 6. Graph showing changes in the surface area, as determined by nitrogen adsorption, of the Olancha fuller's earth as the material is partially dehydrated at various temperatures. Partial dehydration eliminates a portion of the chemically held water within the crystal lattice, which results in a porous structure and an increase in surface area. Too high a dehydration temperature causes these pores to sinter and close with a reduction in surface.

ered in great detail by Marshall (1949). The adsorbing power of fuller's earth has been established as being as great as to cause 1 cu. ft. to adsorb 0.6 lb. lime, thus being equivalent to the acidity of a 2 percent solution of sulfuric acid (Mantell, 1951).

Physical Properties. The particle size distribution of adsorbent clays must be closely controlled during the crushing or grinding operations to insure proper dispersion and decolorizing properties as well as good filtration characteristics and low oil retention. The percolation types of clays are made in granules from 4 to 8 mesh down to as fine as 60 to 90 mesh with any number of intermediate size ranges for various applications. The powdered contact types are generally from 90 to 95 percent through 100 mesh, although grades fine enough to pass 325 mesh completely are also made (Mantell, 1951, p. 48). For the powdered contact clays a knowledge of the complete range of particle size distribution in the sub-sieve ranges is essential in order to control the filtration and oil retention characteristics of the product. The Andreasen pipette method has been found to be an accurate means of testing this property (Loomis, 1938). The specific surface or surface mean diameter, as determined by the air permeability method of Gooden and Smith (1940) is also a valuable tool in controlling particle size and filtration characteristics. These same properties also control, to a certain extent, the rate of adsorption. The finer particle size clays, which present more readily available surface, probably reach an adsorption equilibrium sooner than do the coarser grades of clay.

In order to study the effects of particle size distribution on filtration rate and color removal efficiency, samples of the Olancha fuller's earth were crushed, dried and then pulverized in a Raymond roller mill to a number of different particle size distributions. These were tested for particle size distribution, surface mean diameter, filtration rates and color removing properties using refined soybean oil. Figure 9 shows the particle size distributions of the various products and their corresponding surface mean diameters by air permeability.

Figure 10 shows the filtration characteristics of the same products. Figure 11 shows the size-frequency distribution of these products and figure 12 shows the close relationship between specific surface or surface mean diameter, as determined by air permeability, and filtration properties. Figure 13 shows the spectral transmittance of soybean oil after decolorization with 1 percent of each of these products and figure 14 shows how the adsorption equilibrium rate is increased as the clay is ground successively finer. Unless the range of particle size has been appreciably narrowed by air classification to remove extremely fine particles, it has been found necessary to sacrifice some filtration rate for improved adsorption equilibrium rate.

Figure 15 shows the change in particle shape as this type of material is pulverized successively finer; dm is the surface mean diameter determined by air permeability; Xm is a surface mean diameter obtained by integration of the distribution curve, assuming a spherical particle shape. The ratio dm/Xm is therefore a measure of particle shape or more correctly, deviation from sphericity. The curve illustrates that this type of material tends to become more platy with increasing fineness. Such change in shape can also affect flow-rate properties.

FACTORS AFFECTING ADSORPTION

Chemical Factors

Both fuller's earths and acid-activated clays owe their color removing efficiency or ability to decolorize oils to their great adsorptive capacity. In use the clay is brought into contact with the oil under suitable conditions. The colored materials in the oil are strongly attracted and held to the surfaces of the clay particles. This is known as adsorption and is not to be confused with absorption where the material is held within interstitial space between particles as in a sponge. The mixture of oil and clay is then filtered leaving some of the color in the clay and producing a lighter colored oil.

Many theories have been advanced to explain the action of adsorbent clays. The phenomenon is extremely complex and still incompletely understood. The practice of manufacturing and using adsorbent clays has advanced much faster than the underlying theories. In recent years, however, much basic research has been done on this problem and it is now known that the type of adsorption which takes place at the surface of a clay particle during the decolorization of any oil is chemical as well as physical in nature. The coloring materials in the oil probably undergo a chemical change at the surface of the clay particle and are held by a chemical as well as a physical bond. In activation by acid leaching both the chemical and physical properties of bentonite are radically changed. The ability of these materials to adsorb color is closely related to their molecular structure.

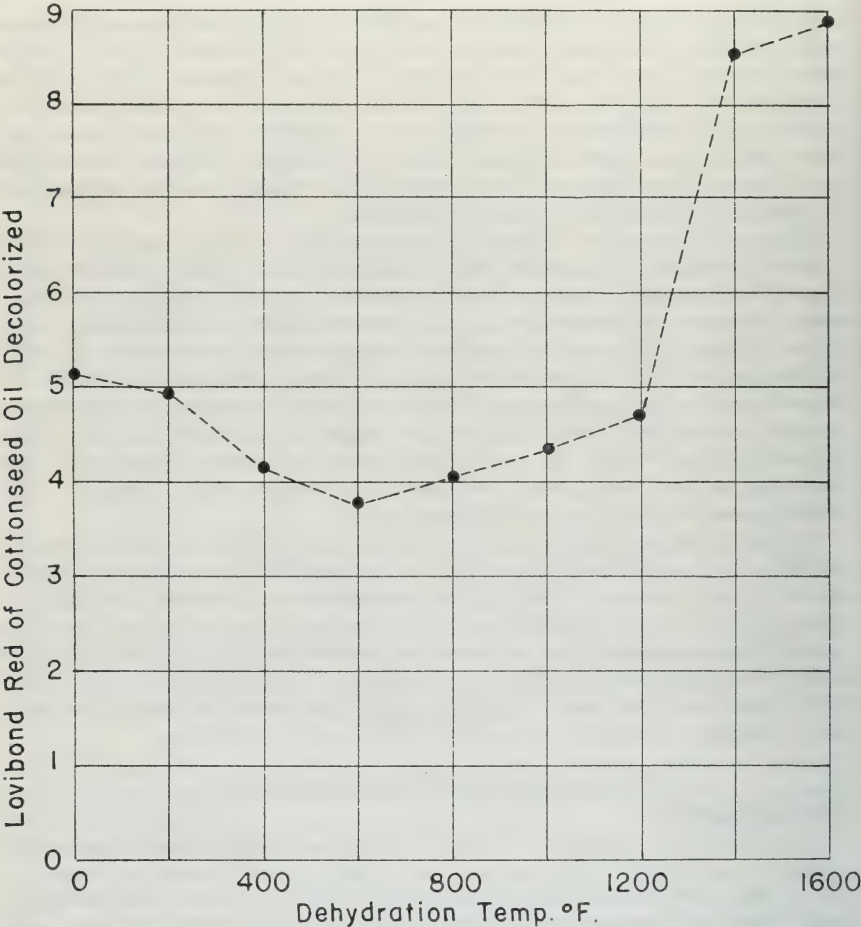


FIGURE 7. Graph showing changes in decolorizing efficiency for the same samples illustrated in figure 6. Maximum decolorizing efficiency is obtained at the temperature of dehydration giving maximum development of porosity or surface area.

The idealized molecular structure of montmorillonite as projected on a plane is shown in figure 1. This structure includes a central layer containing aluminum atoms in octahedral coordination. Each aluminum atom is associated with four oxygen atoms and two hydroxyl groups. Above and below the central aluminum layer there are layers containing silicon in tetrahedral coordination with oxygen. All of these layers unite to form a neutral plane or sheet which is separated from another sheet by an interplaner space which may contain water. The structure is thus repeated. The structure of most bentonites is much more complex because of various ismorphous substitutions.

Montmorillonite, a name also applied to a mineral group, is used specifically for a mineral in which some aluminum from the central layer is replaced by magnesium. Beidellite has a predominant replacement of silicon by aluminum. Nontronite has a large replacement of aluminum by iron. Saponite has a large replacement of aluminum by magnesium. A bivalent atom replacing a trivalent one leaves the crystal lattice negatively charged by an amount equivalent to one valence unit.

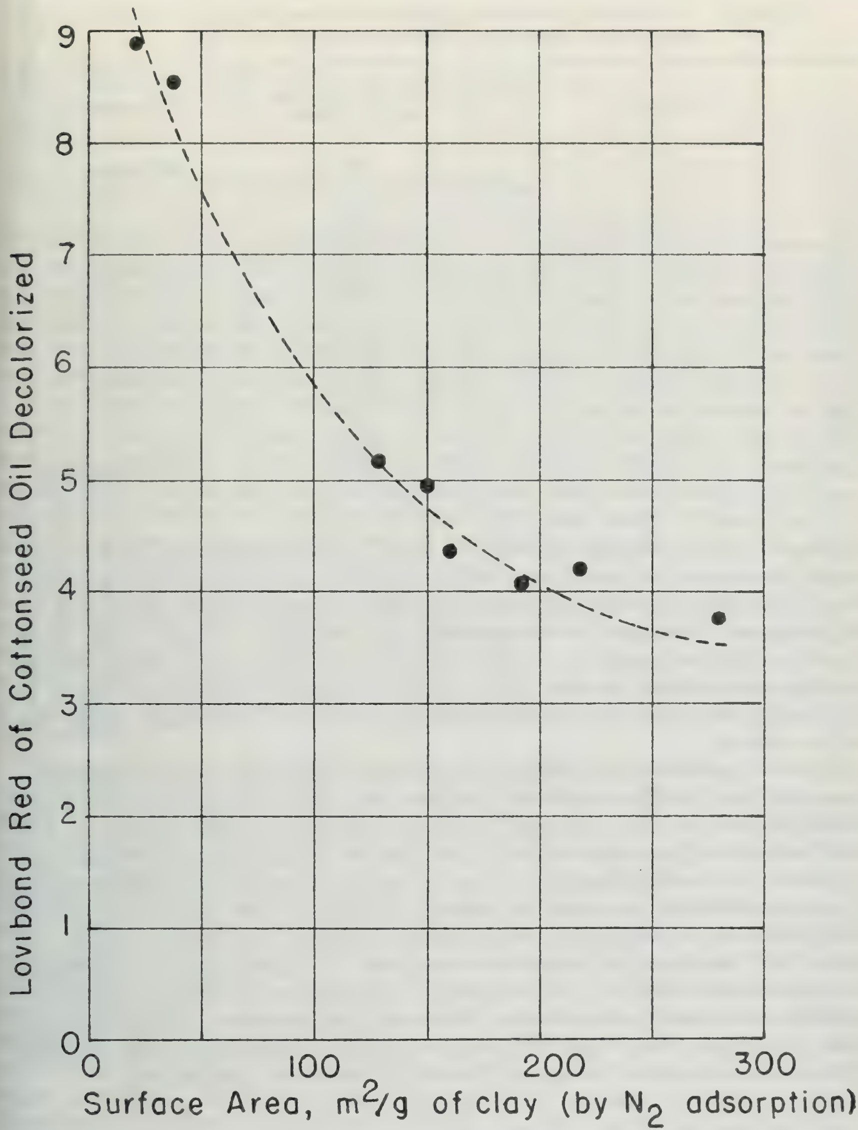


FIGURE 8. Graph showing the close relationship between surface developed by incomplete dehydration and decolorizing efficiency.

Tetrahedrally coordinated aluminum can replace tetrahedrally coordinated silicon in the silica layers. In this substitution a trivalent element replaces a tetravalent one. This also leaves a negative charge on the lattice. Positive ions, such as calcium, magnesium, sodium and potassium, become associated with the structure to neutralize this charge. These so-called base-exchange ions are usually represented as being held in interplanar space.

In 1930 L. Pauling published two papers dealing with the X-ray diffraction patterns produced by minerals with a highly micaceous

Table 2. Conditions of tests that produced changes indicated in Table 3. Acid dosage is pounds of H_2SO_4 per pound of dry clay.

Acid dosage	Initial acid concentration (% H_2SO_4)	Temperature
0.10	3.7	Boiling point
0.15	5.2	" "
0.20	6.9	" "
0.25	8.4	" "
0.30	10.0	" "
0.35	11.4	" "
0.40	12.9	" "
0.45	13.3	" "
0.50	15.7	" "
0.60	19.8	" "
0.70	23.1	" "
0.80	26.4	" "
0.90	29.6	" "
1.00	33.0	" "
1.50	45.0	" "
2.00	66.0	" "
0.30	10.0	Room temperature

cleavage. This work led the way for proper development of the molecular structure of montmorillonite. In 1933, as a result of Pauling's work, Hofmann, Endell and Wilm (1933) in Berlin were successful in assigning a structure to montmorillonite. Winkler (1944) and later Grenall (1946) showed by X-ray diffraction studies that in the montmorillonite molecule, a unit cell is 6.49Å in length along the C axis. It is also known that the dimensions of a unit cell will vary with the water content.

Caglioti and Baroni (1940) showed that only those clays which contain acid soluble MgO and Si-OH groups in their lattice structure are amenable to activation by acid leaching and that the adsorption of colored materials from oils is due to formation of compounds between the clay and colorant. It has been recently shown that proper acid leaching of montmorillonite removes substantially half of the central layer of aluminum. An idealized structure of the activated material is shown in figure 2. This leaves a negative charge on the lattice and a hydrogen ion becomes associated with the lattice to neutralize this charge. Catalytic activity and decolorizing efficiency have been shown to be associated with these hydrogen ions. The following equations summarize the type of changes taking place during acid leaching of montmorillonite:

$$(Al_4)(Si_8)O_{20}(OH)_4 + 3H^+ \rightarrow \overset{\overset{H+}{\uparrow}}{(Al_3)}(Si_8)O_{20}(OH)_2 + Al^{+++} + 2H_2O$$

$$(Al_4)(Si_8)O_{20}(OH)_4 + 6H^+ \rightarrow \overset{\overset{2H+}{\uparrow}}{(Al_2)}(Si_8)O_{20} + 2Al^{+++} + 4H_2O$$

At this stage one-half the aluminum is removed and the structure is as shown in the molecular diagram (fig. 2). Further leaching with mineral acid attacks these remaining tetrahedrally coordinated aluminum atoms as follows:

$$\begin{array}{l} \text{H}+ \qquad\qquad\qquad\qquad\qquad \text{H}+ \\ \uparrow \qquad\qquad\qquad\qquad\qquad\quad \uparrow \\ \text{l}_2)(\text{Si}_8)\text{O}_{20} + 3\text{H}^+ \rightarrow \text{Al}^{+++} + (\text{Al})(\text{Si}_8\text{H}_4)\text{O}_{20} \end{array}$$

$$\begin{array}{l} \text{H}+ \\ \uparrow \\ \text{l}_2)(\text{Si}_8)\text{O}_{20} + 6\text{H}^+ \rightarrow 2\text{Al}^{+++} + (\text{Si}_8\text{H}_8)\text{O}_{20} \end{array}$$

rom the above it is apparent that if all of the aluminum is removed e end product will be disilicic acid which has little if any decolorizing ficiency for the colorants found in oils. Therefore, in practice, leaching nditions such as acid concentration, temperature and reaction time e carefully adjusted to remove the proper amount of aluminum, iron d magnesium from this central layer to give optimum activity.

The Olancha fuller's earth, mined in Inyo County, California, is unsual in that it possesses very strong, natural color-removing power d also responds to activation by acid leaching. In an acid leaching udy of this material, sulfuric acid was used. The acid to clay ratio was anged as was the acid concentration. Tests were made by leaching the ixture at room temperature and at the boiling temperature. The acid clay ratios and the initial concentrations of the acid in each of these sts are shown in table 2. The leaching was done for 6.5 hours by refluxg the mixture. After leaching the samples were filtered and washed by peated decantations and filtrations until free of any residual acid or luble salts. The samples were then dried and allowed to rehydrate equilibrium moisture content. Table 3 shows the change in chemical mposition.

Thomas, Hickey and Stecker (1950) showed that leaching at room mperature does not attack the central aluminum layer but does reove all of the base exchangeable ions. Therefore it is indicated from is study that most of the iron in the Olancha clay is present in the ntral layer replacing aluminum to give a nontronite composition. agnesium is also present largely in the center layer indicating sapoite. From the above it can be seen that as the severity of leaching is creased the decolorizing efficiency of the leached clay should increase, pproach an optimum when approximately one-half the center layer as been removed, and should then start to decline. These samples of ached Olancha clay were used to decolorize various oils and their deolorizing efficiencies evaluated. Figures 3, 4, and 5 illustrate these findgs. Lovibond colors were determined by the tentative method of the merican Oil Chemists Society (1950). In the Lovibond method for olor grading higher red unit values indicate darker oil colors.

These decolorizing tests indicate that efficiency of the clay is increased s the acid concentration is increased and that optimum properties are btained when from 0.35 to 0.50 pounds of sulfuric acid per pound of lay are used. Under these conditions approximately one-half of the entrally held atoms are removed. Leaching with increased amounts of cid causes this structure to collapse as the centrally held, tetrahedrally oordinated aluminum is removed. This decreases the concentration of ydrogen ions associated with the lattice and the decolorizing efficiency eclines as the composition of disilicic acid is approached.

Table 3. Chemical analyses of samples of Olancha fuller's earth following acid treatment as shown in Table 2.

Sample	H_2O-	H_2O+	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MnO	CaO	MgO	Na_2O	K_2O	Total
Raw Olancha clay	11.19	5.72	58.63	12.76	5.92	0.72	0.030	1.38	3.39	0.91	1.65	102.27
0.10 lbs. H_2SO_4/lb. of clay	8.82	6.30	63.40	12.67	4.89	0.72	0.021	1.30	2.50	0.91	1.42	102.95
0.15 lbs. H_2SO_4/lb. of clay	8.93	6.43	64.20	11.89	4.28	0.70	0.018	1.29	2.21	0.89	1.18	102.02
0.20 lbs. H_2SO_4/lb. of clay	8.57	6.42	64.90	11.40	4.00	0.68	0.014	1.08	2.01	0.88	1.16	101.11
0.25 lbs. H_2SO_4/lb. of clay	9.95	5.92	65.65	10.58	3.58	0.64	0.009	1.05	1.69	0.78	1.09	100.93
0.30 lbs. H_2SO_4/lb. of clay	10.68	5.78	66.00	10.19	3.12	0.64	0.009	1.03	1.50	0.75	1.04	100.73
0.35 lbs. H_2SO_4/lb. of clay	10.64	5.92	66.95	10.05	2.93	0.63	0.009	1.04	1.43	0.74	1.05	101.38
0.40 lbs. H_2SO_4/lb. of clay	9.24	5.01	67.85	9.33	2.72	0.63	0.006	0.96	1.06	0.69	1.00	98.49
0.45 lbs. H_2SO_4/lb. of clay	9.03	4.77	70.70	8.82	2.65	0.60	0.005	0.95	1.01	0.67	1.00	99.66
0.50 lbs. H_2SO_4/lb. of clay	7.30	5.22	73.45	8.47	1.53	0.58	0.005	0.89	0.71	0.59	0.98	99.72
0.60 lbs. H_2SO_4/lb. of clay	6.84	4.93	76.90	6.89	1.36	0.58	0.003	0.82	0.69	0.56	0.95	100.52
0.70 lbs. H_2SO_4/lb. of clay	5.83	4.42	81.05	5.23	0.93	0.54	trace	0.80	0.60	0.51	0.94	100.85
0.80 lbs. H_2SO_4/lb. of clay	5.32	4.15	81.93	4.71	0.69	0.53	none	0.75	0.52	0.48	0.90	99.98
0.90 lbs. H_2SO_4/lb. of clay	5.12	3.81	83.66	4.08	0.62	0.36	none	0.72	0.41	0.47	0.86	100.11
1.00 lbs. H_2SO_4/lb. of clay	4.56	4.24	84.60	3.99	0.36	0.27	none	0.70	0.24	0.47	0.71	99.51
1.50 lbs. H_2SO_4/lb. of clay	3.98	4.05	87.30	3.78	0.32	0.15	none	0.68	trace	0.41	0.69	101.36
2.00 lbs. H_2SO_4/lb. of clay	3.09	4.17	88.40	3.50	0.26	0.05	none	0.60	none	0.36	0.65	101.08
0.30 lbs./lb. clay	8.80	5.74	61.95	10.56	5.19	0.60	0.026	0.85	2.46	0.78	1.09	98.05

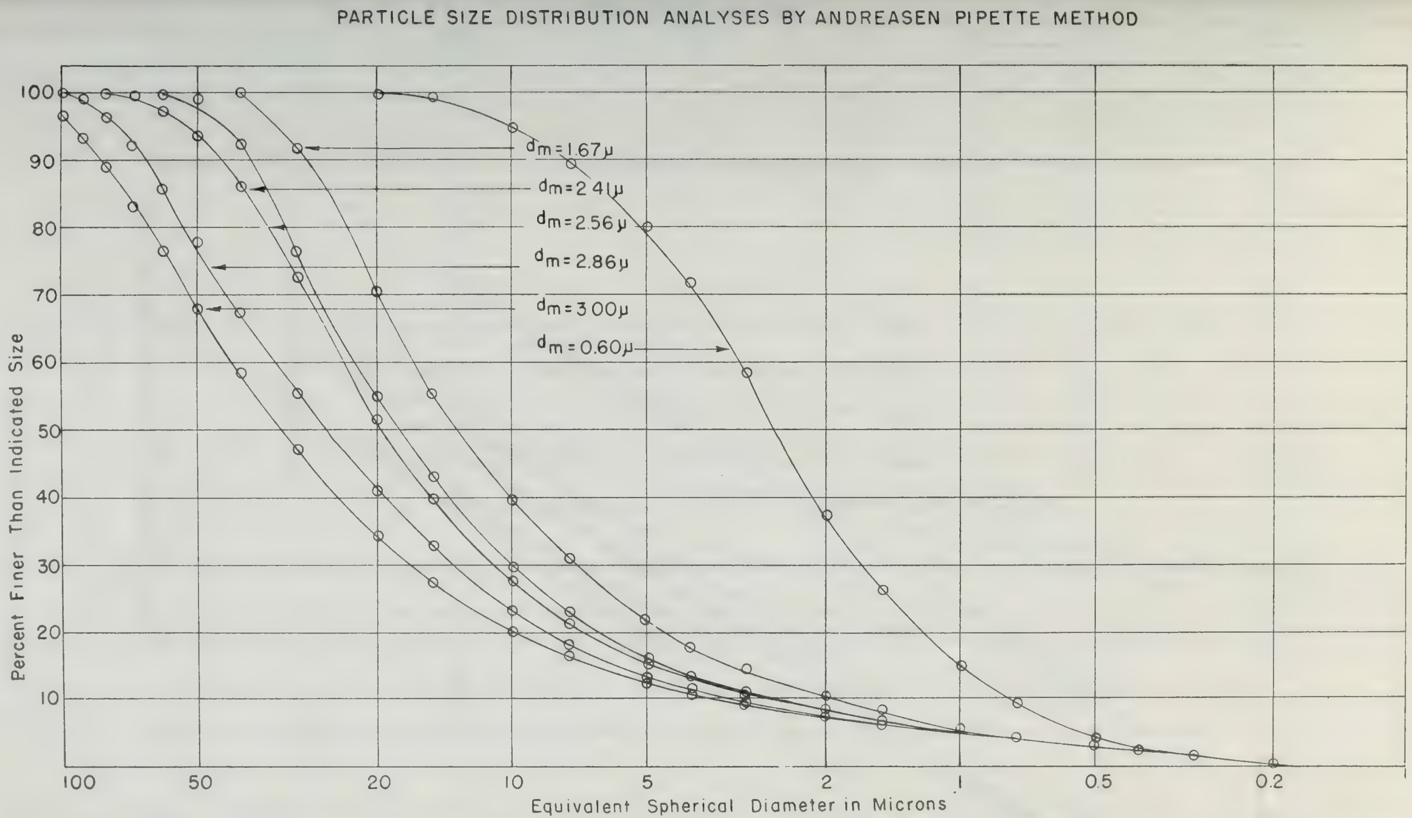


FIGURE 9. Particle size distribution of Olancha fuller's earth, pulverized in a Raymond, ring-roll mill. The d_m values represent the surface mean diameter, in microns, of each sample as determined by air permeability.

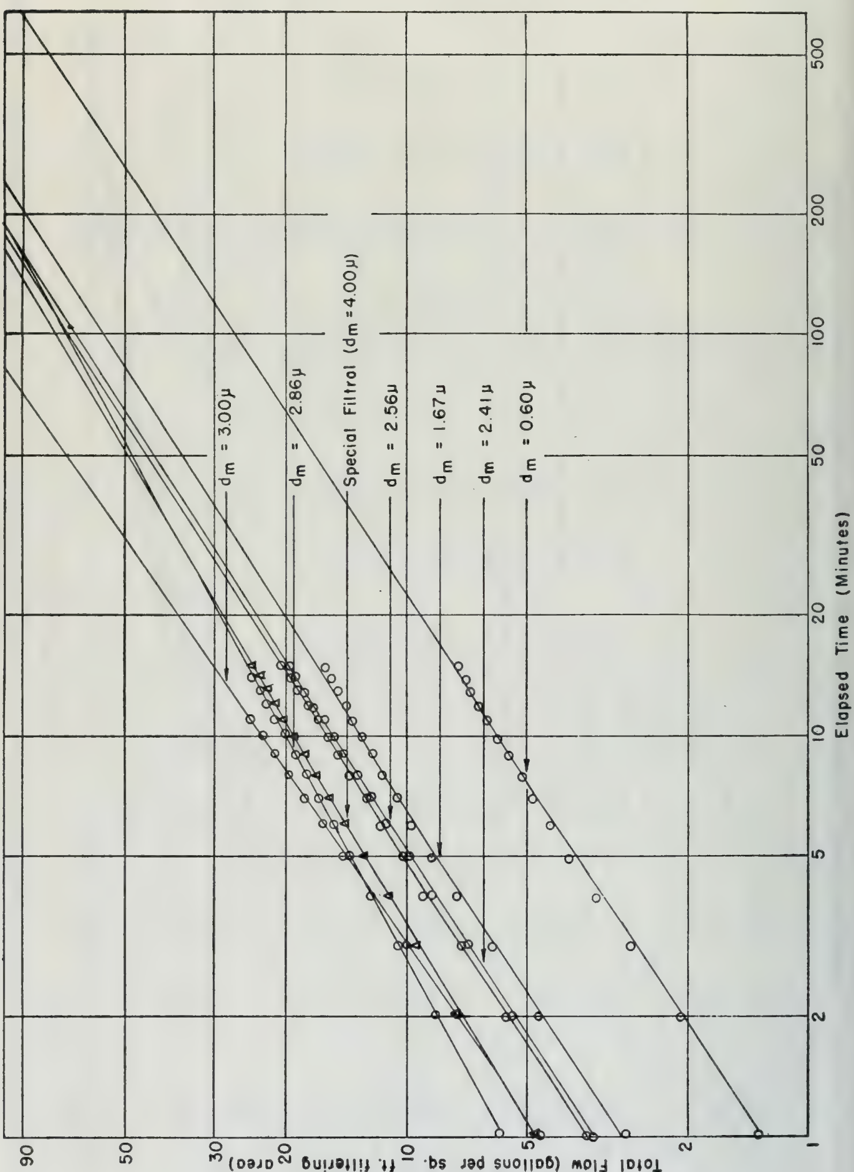


FIGURE 10. Filtration rate properties of the various sample grinds described in figures 9 and 10.

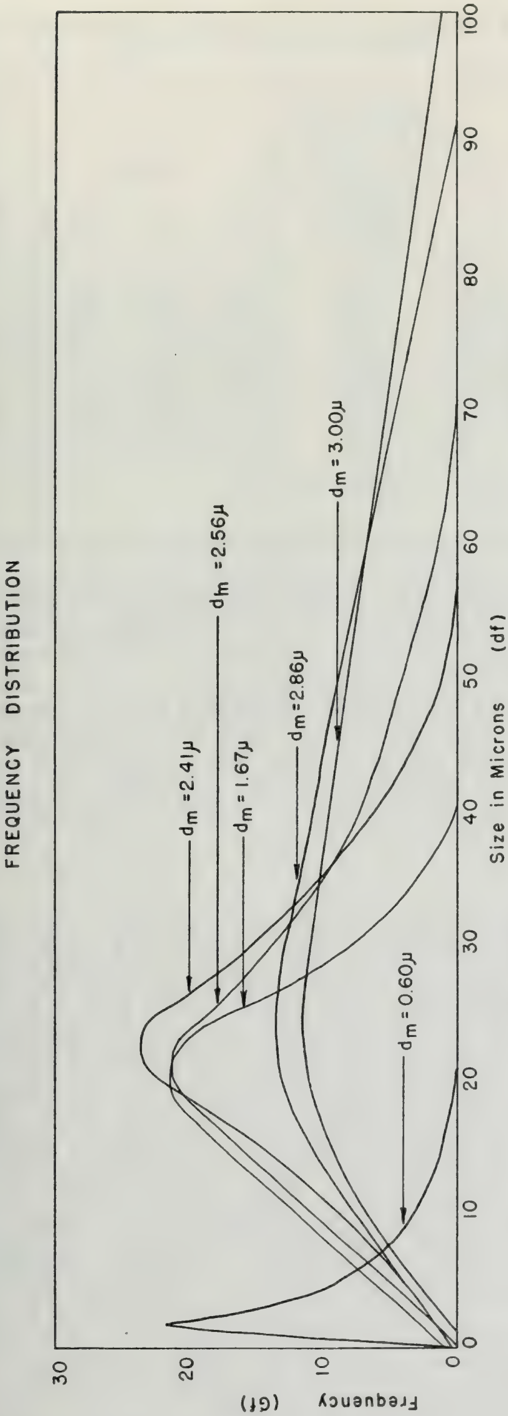


FIGURE 11. Same data, as shown in figure 9, represented as a frequency distribution plot of particle size.

Table 4. Changes in acidity of Olancha clay produced by acid leaching tests indicated in table 2.

Sample	Acidity changes in Olancha clay occurring with acid leaching* (Acidity as milliequivalent of NaOH/g. dried clay)	Sample	Acidity changes in Olancha clay occurring with acid leaching* (Acidity as milliequivalent of NaOH/g. dried clay)
Raw Olancha clay	0.46	0.50 lbs. H_2SO_4/lb. clay B.P.	0.88
0.10 lbs. H_2SO_4/lb. clay B.P.	0.70	0.60 lbs. H_2SO_4/lb. clay B.P.	0.80
0.15 lbs. H_2SO_4/lb. clay B.P.	0.81	0.70 lbs. H_2SO_4/lb. clay B.P.	0.60
0.20 lbs. H_2SO_4/lb. clay B.P.	0.85	0.80 lbs. H_2SO_4/lb. clay B.P.	0.56
0.25 lbs. H_2SO_4/lb. clay B.P.	0.88	0.90 lbs. H_2SO_4/lb. clay B.P.	0.54
0.30 lbs. H_2SO_4/lb. clay B.P.	0.91	1.00 lbs. H_2SO_4/lb. clay B.P.	0.53
0.35 lbs. H_2SO_4/lb. clay B.P.	0.92	1.50 lbs. H_2SO_4/lb. clay B.P.	0.49
0.40 lbs. H_2SO_4/lb. clay B.P.	0.88	2.00 lbs. H_2SO_4/lb. clay B.P.	0.46
0.45 lbs. H_2SO_4/lb. clay B.P.	0.90	0.30 lbs. H_2SO_4/lb. clay R.T.	0.77

* Acidity determined by potentiometric titration with N/10 NaOH.

The total acidity of each acid-leached Olancha clay sample is shown in table 4. Disilicic acid, the end-product of overactivation, is present to a significant extent in properly activated clays, but is weakly acidic and probably only slightly reactive with NaOH under the test conditions. Therefore the NaOH titrations are largely indicative of the hydrogen ions associated with the crystal lattice.

These data illustrate the close correlation between the acidity of the activated Olancha clay samples and their decolorizing efficiencies as determined with alkali refined soybean oil. For the other oils tested the relationship was not found to be as close, indicating that properties other than hydrogen ion concentration are probably important to the mechanism of adsorption.

Physical Factors

Most adsorbents such as fuller's earth, activated clay, bauxite, bone char and activated carbon are characterized by a highly porous structure, and therefore possess very large specific surfaces. For example some grades of activated carbon used as adsorbents show a specific surface as great as 2000 m^2/g. The more active grades of fuller's earth develop from 60 to 70 percent porosity and surface areas of 120 to 140 m^2/g (Mantell, 1951, p. 48). The American Oil Chemists Society standard for natural clay shows a specific surface of 33 m^2/g. This material possesses very poor color adsorptive powers. Because adsorption takes place at the adsorbent-liquid interface, the specific surface of the adsorbent is an important property. The magnitude of the total surface as well as the sizes of the pores and capillaries, which constitute by far the greatest source of surface area, are also important considerations. Surface area may be determined by three principal methods (See Loebenstein and Deitz, 1951, Gooden and Smith, 1940, Dalle Valle, 1943):

(1) By nitrogen adsorption which measures not only surface due to the exterior geometrical shape of the adsorbent particles but also includes surface due to surface irregularities, pores and capillaries.

(2) By air permeability which measures only surface due to the size and exterior geometric shape of the adsorbent particles.

Table 5. Changes in specific gravity and specific surface of samples of Olancha clay after leaching with various amounts of sulfuric acid. Specific surface determined by nitrogen adsorption method.

Sample	Apparent specific gravity @ 25°C.	Specific surface m^2/g.
Raw Olancha clay	2.52	128
0.10 lbs. H_2SO_4/lb. clay, B.P.	2.52	174
0.15 lbs. H_2SO_4/lb. clay, B.P.	2.47	203
0.20 lbs. H_2SO_4/lb. clay, B.P.	2.45	252
0.25 lbs. H_2SO_4/lb. clay, B.P.	2.50	271
0.30 lbs. H_2SO_4/lb. clay, B.P.	2.42	269
0.35 lbs. H_2SO_4/lb. clay, B.P.	2.39	270
0.40 lbs. H_2SO_4/lb. clay, B.P.	2.38	296
0.45 lbs. H_2SO_4/lb. clay, B.P.	2.35	307
0.50 lbs. H_2SO_4/lb. clay, B.P.	2.29	340
0.60 lbs. H_2SO_4/lb. clay, B.P.	2.29	367
0.70 lbs. H_2SO_4/lb. clay, B.P.	2.26	321
0.80 lbs. H_2SO_4/lb. clay, B.P.	2.22	212
0.90 lbs. H_2SO_4/lb. clay, B.P.	2.19	176
1.00 lbs. H_2SO_4/lb. clay, B.P.	2.21	174
1.50 lbs. H_2SO_4/lb. clay, B.P.	2.22	154
2.00 lbs. H_2SO_4/lb. clay, B.P.	2.23	102
0.30 lbs. H_2SO_4/lb. clay, R.T.	2.52	134

(3) By integration of the particle size distribution curve which necessitates the assumption that the adsorbent particles are non-porous and are perfect spheres.

Of the three methods, the first, surface area by gas adsorption, is probably the most valuable in studying the physical properties that affect the decolorizing efficiencies of adsorbent clays. Gas adsorption methods have been further refined to measure not only total surface area but pore or capillary size-surface distribution in adsorbents (Oulton, 1945).

By these methods it has been determined that the pores in some fuller's earths have mean equivalent diameters of 190 to 200 Å. One grade of activated clay produced in California was determined to have the greatest proportion of its surface present as pores between 26 and 27 Å diameter. In order to be adsorbed a color molecule in an oil must fit inside the pores of the adsorbent. Variations in the pore structure among different clays may help explain why one clay may be highly effective in one color-removing application and yet very poor in some other application. By far the greatest amount of surface in adsorbent clays is due to internal pore structure rather than to exterior geometric size and shape of the particles.

One grade of activated clay, for example, showed a surface area of 300 m^2/g in both the 0-40 and 40-100 micron fractions. This same material showed a surface area of only 0.574 m^2/g by air permeability. A sample of the fuller's earth mined near Olancha, California showed a surface area of 128 m^2/g by nitrogen adsorption and only 0.866 m^2/g by air permeability, indicating a highly porous structure. The A.O.C.S. standard natural clay shows a surface of 33 m^2/g by nitrogen adsorption and only 0.343 m^2/g by air permeability.

Activation of clays by acid leaching is known to affect the physical as well as chemical properties of the clay. Surface area can be tremendously increased by acid leaching. At the same time the pore size—surface area distribution is radically altered. In the same study of activa-

Table 6. Changes in specific surface of Olancha fuller's earth when activated by partial dehydration at various temperatures.

Dehydration Temperature ° F.	Specific surface, m$_2$g. by nitrogen adsorption	Dehydration Temperature ° F.	Specific surface, m^2/g. by nitrogen adsorption
0	128	1000	160
200	150	1200	152
400	217	1400	37
600	280	1600	21
800	193		

tion of Olancha clay by acid leaching, the specific gravity of the anhydrous clay, as measured by means of a pycnometer and dispersion in kerosene at 25°C., was determined. Surface area by nitrogen adsorption was also determined. The results are shown in table 5. These results indicate the development of a porous structure as leaching progresses and then a collapse of that structure as leaching conditions become too severe.

Drying of fuller's earth greatly increases its specific surface and adsorptive capacity. Elimination of free and combined water leaves openings in the crystal lattice which are highly active positions for color adsorption. Fitzsimons, Amero and Capell (1941) determined that the activity of a particular fuller's earth as determined by decolorizing efficiency of lubricating oils increased almost linearly with increasing temperature of activation from 400 to 1250° F. Above 1300° F. the activity was found to decrease rapidly with increases in activation temperature.

The optimum temperature for activation by partial dehydration varies, depending upon the specific clay. Samples of Olancha fuller's earth were dehydrated at temperatures from 200° F. to 1600° F. in steps of 200° F. Specific surface by nitrogen adsorption was determined for each sample. The changes in specific surface are shown in table 6.

Table 7. Table showing the decolorizing efficiency on refined cottonseed oil of Olancha clay activated by dehydration at various temperatures. Figures in the four middle columns show percent transmittance at each indicated wave length. Higher transmittance figures at each wave length indicate lighter oil colors. Higher values for Lovibond Red indicate darker oil colors. Each oil sample treated at 110° C for 5 minutes with 1% clay based on weight of oil.

Dehydration temperature, ° F.	Percent transmitted				Lovibond Red
	460μ	550μ	620μ	670μ	
0	13.0	87.2	96.0	96.6	5.17
200	16.0	87.4	96.2	96.6	4.95
400	28.6	88.2	96.2	96.0	4.19
600	34.4	89.0	96.4	96.0	3.78
800	32.0	88.4	96.2	96.0	4.06
1000	34.8	87.8	95.6	95.0	4.34
1200	30.8	87.0	95.6	96.0	4.69
1400	18.4	77.0	94.0	94.4	8.58
1600	6.2	76.0	93.0	91.0	8.88
Unbleached oil	6.2	79.4	93.0	93.0	7.98

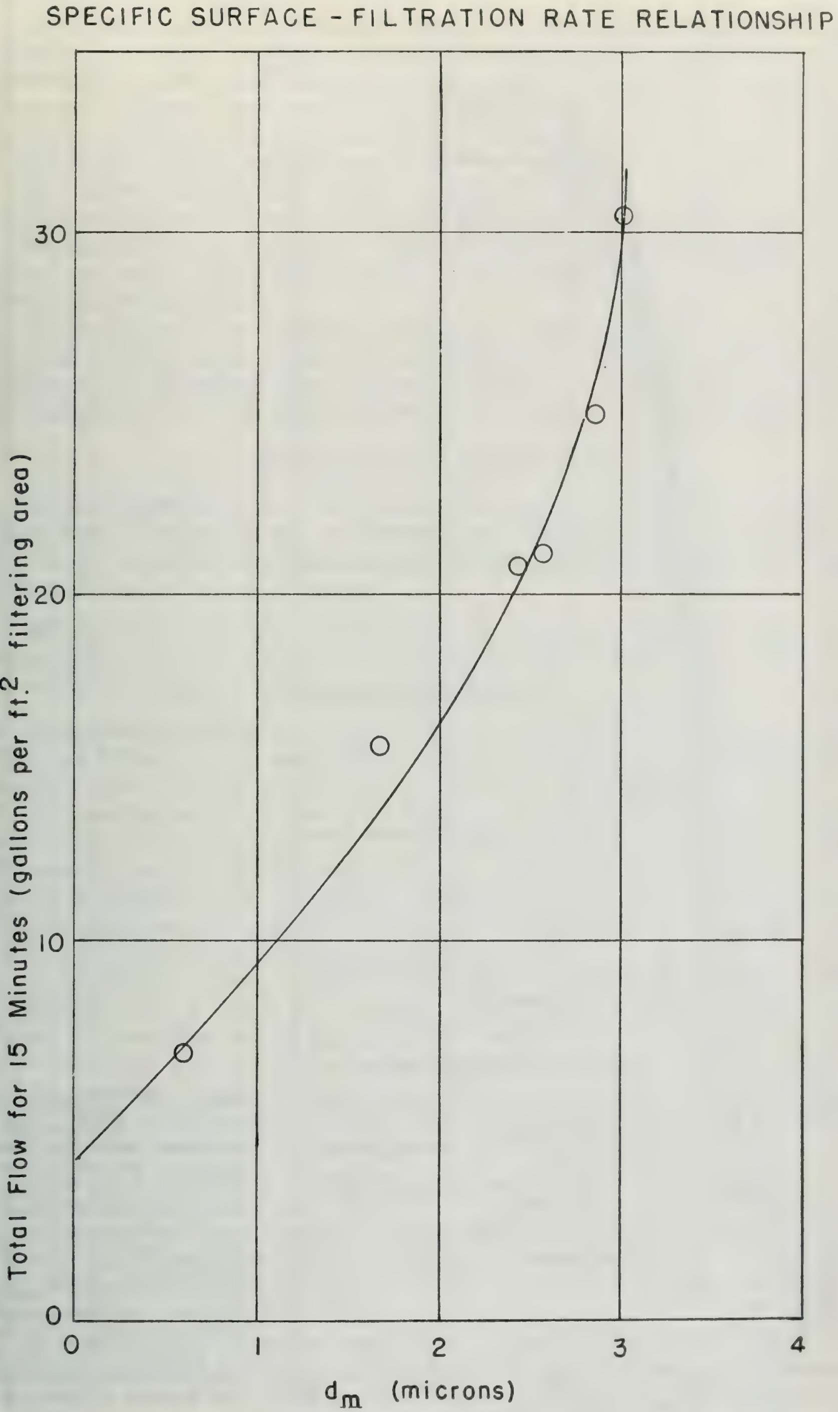


FIGURE 12. Curve showing the close relationship between surface area, as indicated by air permeability surface mean diameter, and flow rate characteristics. Lower surface mean diameters indicate smaller particle size.

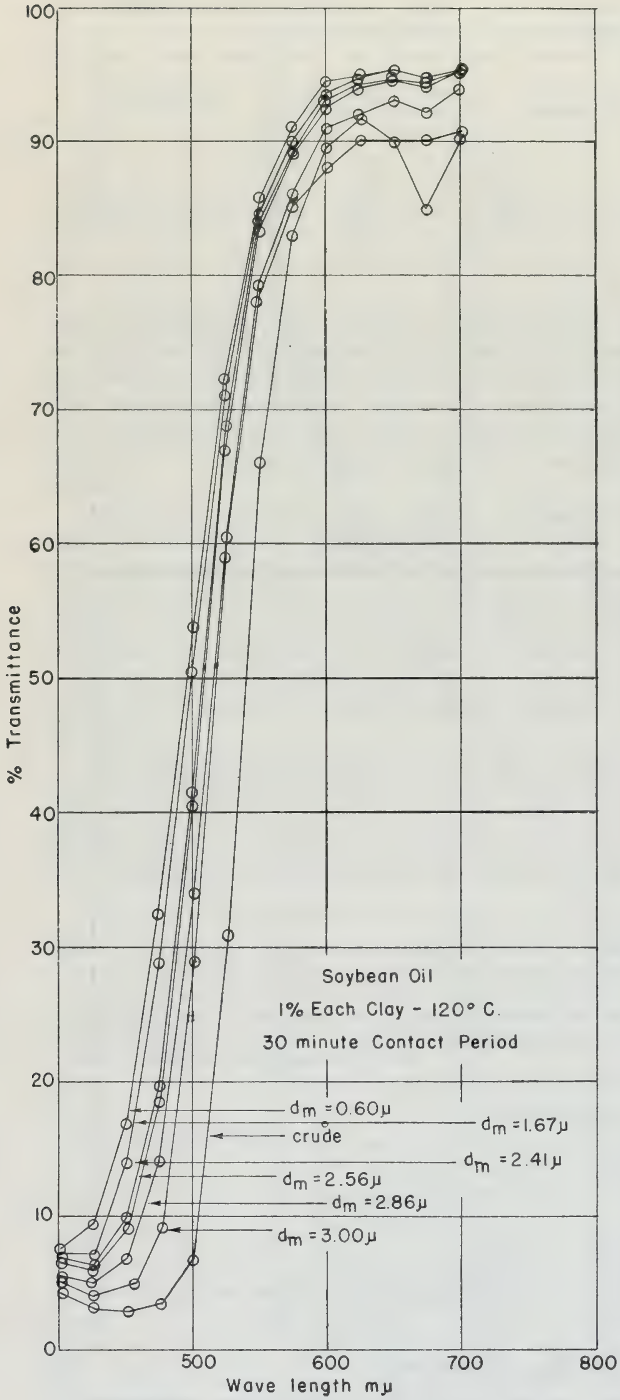


FIGURE 13. Changes in decolorizing efficiency with increases in fineness of the adsorbent clay. The curves represent the spectral transmittance of refined soybean oil before and after clay treatment. The measurements were made over the entire range of the visual spectrum from 400 to 700 millimicrons. Higher transmission values indicate lighter colors. Measurements were made using a Beckman DU spectrophotometer, 1.00 cm lightpath cells and distilled water as a reference of 100 percent transmittance.

These measurements illustrate the development of a highly porous structure as water is removed from the clay molecule. Additional heat produces a sintering effect causing the pores to collapse with a resulting decrease in specific surface. For the Olancha clay the optimum heat was 600° F. while for the clay studied by Fitzsimons, Amero and Capell, 1250° F. was the optimum.

The same clay samples shown in table 6 were used to decolorize a sample of refined cottonseed oil. Table 7 shows the results of these decolorization tests. A close correlation is shown between dehydration temperature, surface area and decolorizing efficiency. Figures 7 and 8 illustrate this relationship.

Properties such as moisture content and acidity due to mineral acid left in the clay after leaching are also known to affect the decolorizing efficiency of adsorbent clays. However, much work remains to be done in correlating all these factors affecting the adsorptive capacity of clays.

MINING AND MANUFACTURE

Geologic Occurrence. Fuller's earths are known to exist in sedimentary beds of Mesozoic age or younger age. Most bentonite and fuller's earth are probably derived from the alteration of vitric tuffs after decomposition in bodies of water.

Mining Methods. Most deposits of bentonite or fuller's earth are worked by open pit methods. The Olancha fuller's earth mine, however, is worked largely by underground methods.

Location and History of Operations. From 1899, when the production of fuller's earth was first recorded in California, until 1919 the output was obtained mainly from Calaveras and Solano Counties. By 1919 deposits had been found in Kern, Los Angeles, San Diego, Riverside and Fresno Counties. In 1919 fuller's earth was mined in Kern, Riverside and Solano Counties. The production from 1899 to 1919, as given in records of the California Division of Mines, is shown in table 8. This output, as is that of today, was used mostly in the decolorizing and filtering of refined mineral and vegetable oils.

A deposit of fuller's earth in Los Angeles County was noted in 1917 (Merrill, 1917, p. 500). In the same year a fuller's earth deposit near Lake Elsinore was being mined by the California Clay Manufacturing Company. An analysis of this material showed SiO_2, 52.4 percent; Al_2O_3, 25.84 percent; Fe_2O_3, 2.24 percent; TiO_2, 1.00 percent; CaO, 0.74 percent; MgO, 0.22 percent; $(K,Na)_2O$, 0.82 percent; SO_3, 0.11 percent; and ignition loss, 9.10 percent (Merrill, 1917, p. 114).

In 1914 a deposit of saponite or montmorillonite was reported near Otay in San Diego County (Merrill, 1914, p. 688). At that time no commercial use had been found for this material. Later, commercial shipments were made from this deposit, the material being sold under the trade name of "Otaylite" and used to decolorize petroleum oils in the Los Angeles area (Pabst, 1938).

A large deposit of fuller's earth of commercial importance was developed near Tehachapi Pass in Ventura County. It became a significant source but is now idle. This deposit was described by Kerr and Cameron (1936). Another important source of fuller's earth in the past was a deposit near Muroc dry lake in Kern County. In recent years a large

Table 8. Production of fuller's earth in California during the period 1899 to 1919. Data from publications of California Division of Mines.

Year	Tons	Value	Year	Tons	Value
1899	620	$12,400	1911	466	$5,294
1900	500	3,750	1912	876	6,500
1901	1,000	19,500	1913	460	3,700
1902	987	19,246	1914	760	5,928
1903	250	4,750	1915	692	4,002
1904	500	9,500	1916	110	550
1905	1,344	38,000	1917	220	2,180
1906	440	10,500	1918	37	333
1907	100	1,000	1919	385	3,810
1908	50	1,000			
1909	459	7,385	Total	10,596	$163,148
1910	340	3,820			

deposit of fuller's earth near Olancha, Inyo County has been operated on a rather large scale and remains the principal source in California.

At present (September 1952) there are four plants within California, in which adsorbent clays were being prepared for market; three are in Los Angeles, the fourth in Berkeley. Of the Los Angeles plants, one operated by the Filtrol Corporation employs clay obtained chiefly from a deposit in Arizona. The clay processed in another, operated by the Los Angeles Chemical Company, is mined from a deposit near Ash Meadows, Nevada, close to the California-Nevada line. Clay for the third plant, operated by the Sierra Talc and Clay Company, is obtained from a deposit near Olancha at the southern end of Owens Valley. The Berkeley plant is operated by the Industrial Minerals and Chemical Company and processes clay from a Nevada source.

PROCESSING

Correct processing of both fuller's earths and activable bentonites in order to develop optimum adsorptive properties is as important as having a proper source of raw clay. As has been pointed out, some bentonites show color-removing properties only after chemical or physical activation or both and extremely careful control of these processes is necessary in order to develop maximum activity.

Processing Fuller's Earth

Processing of fuller's earth is usually less complicated and less difficult than processing activable bentonites. In manufacturing the Olancha fuller's earth the following steps are followed:

(1) The material as received from the mine is crushed to minus ¼ inch in a rotary, dry-pan type of crusher.

(2) The crushed clay is elevated into a storage tank from where it is fed by gravity through a poidometer feeder into a pug mill.

(3) In the pug mill it is mixed with an amount of water sufficient to produce a uniform water content in the discharge product.

(4) The extruded discharge having the consistency of heavy mud, is elevated and dropped into the upper end of a gas-fired rotary dryer. The moisture content of the discharge is controlled by regulating the temperature at the lower end of the dryer.

(5) The dryer discharge is elevated and passed over vibrating screens for the production of sized granules. These drop into a separate storage bin and are taken off in open mouth, multi-walled paper bags.

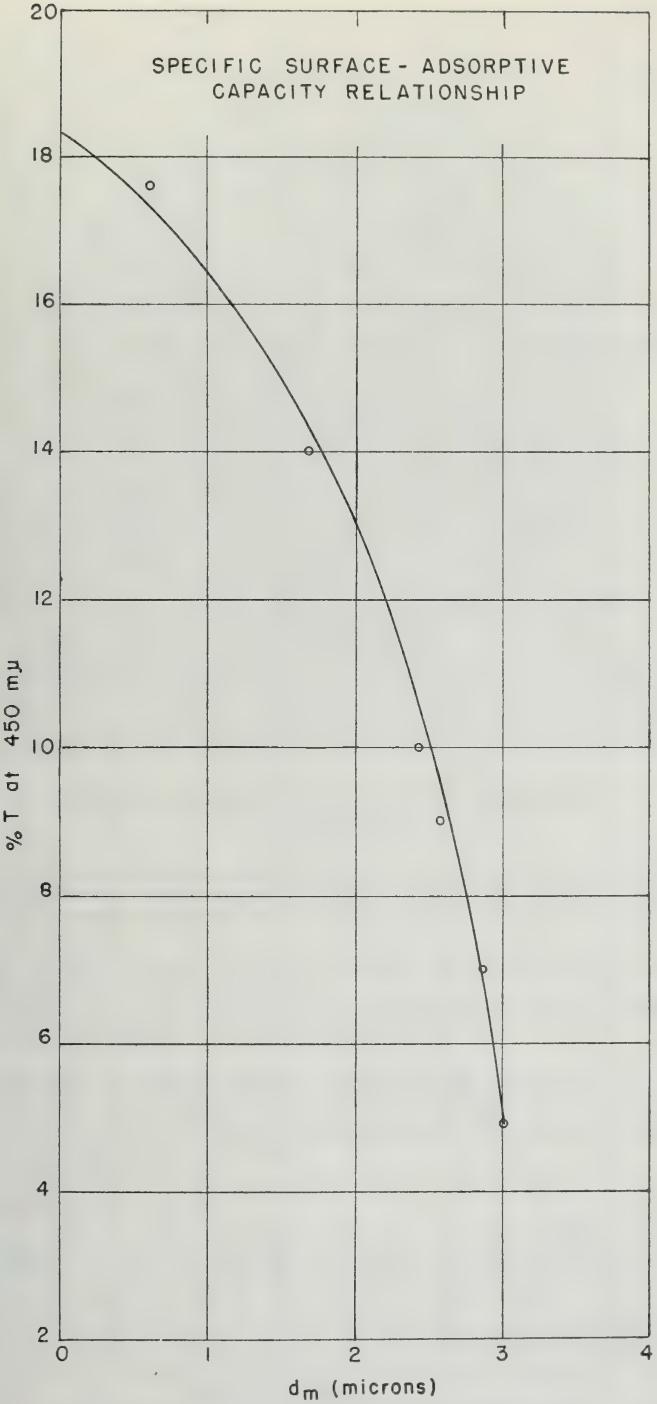


FIGURE 14. A plot of the data in figure 13 showing the changes in decolorizing efficiency, expressed as percent transmittance at 450 millimicrons, against surface area expressed as surface mean diameter as determined by air permeability.

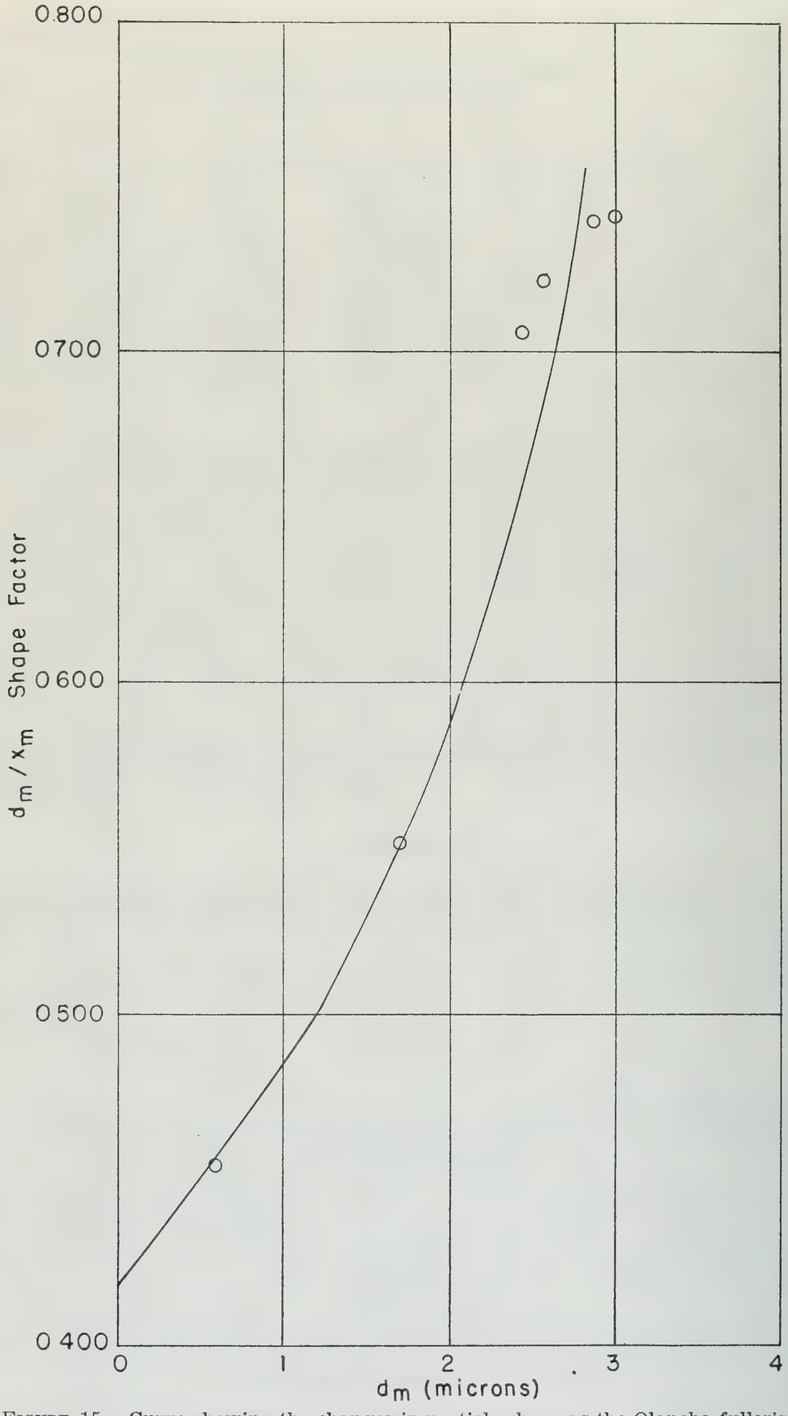


FIGURE 15. Curve showing the changes in particle shape as the Olancha fuller's earth is pulverized successively finer. The value d_m represents surface mean diameter as determined by air permeability. The value Xm represents a surface mean diameter obtained by integration of the frequency distribution curves shown as figure 11. This value is determined assuming spherical particles. For perfect spheres the ratio $d_m/Xm = 1$. Any deviation from a spherical shape lowers this ratio. The curve here indicates an increasing platy structure with increasing fineness of grind.

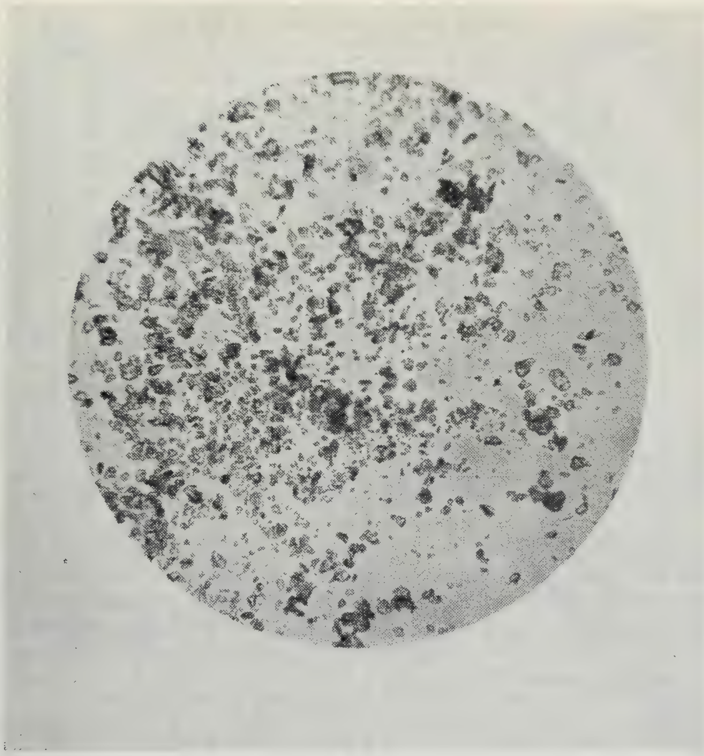


FIGURE 16. Photomicrograph of Olancha fuller's earth as it is normally prepared for use in the oil industry. Magnification—215 ×.

(6) The over-size and under-size from the screening operation are discharged into another storage tank and fed by gravity to a Raymond roller mill, equipped with a whizzer separator and automatic baghouse, to be pulverized for contact type clays.

(7) The powdered material is fed to a storage tank and packed automatically in 50-pound, sleeve-type paper bags.

(8) The bags are loaded on wooden pallets and handled one ton at a time by a lift truck for loading into rail cars or trucks.

The drying, grinding and air classification processes are carefully controlled and the product is constantly checked in the laboratory to insure proper quality. Similar processing steps are taken by other manufacturers of fuller's earth.

Processing Activated Clays

The manufacture of activated clays by acid leaching or treatment is more difficult to control and the processes more complicated than those necessary for fuller's earth. As noted by Rich (1949) there are seven steps in the manufacture of acid-leached clays: (1) preparing the raw clay for charging to treaters or reaction vessels, (2) activating, (3) washing out impurities, (4) dewatering out impurities, (5) drying, (6) grinding to proper mesh size, (7) packaging.

The raw clay is usually prepared by crushing to minus $\frac{1}{4}$ inch. It may or may not be dried before feeding to the reaction vessels. In the re-

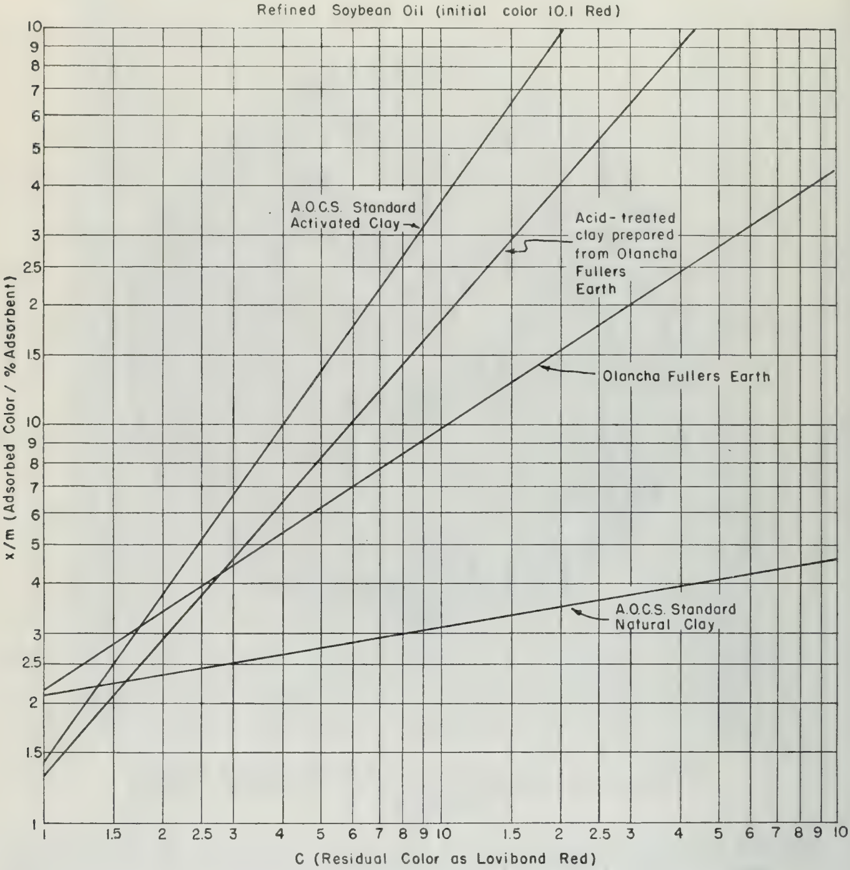
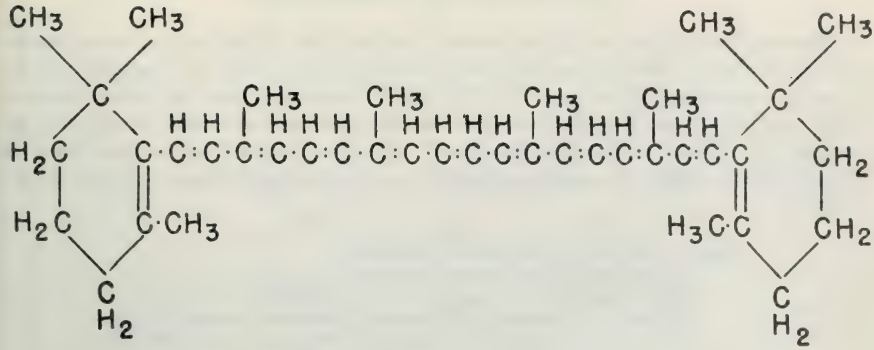


FIGURE 17. Freundich adsorption isotherms for several decolorizing clays.

action vessels the clay is mixed with water and mineral acid in carefully proportioned quantities. In the United States sulfuric acid is generally used because of low cost. However, in Germany hydrochloric acid is used.

The mixture is agitated, either mechanically or by forced air, and heated to the boiling temperature by means of steam. Acid concentration and reaction time (from 2 to 12 hours) vary according to the nature of the raw clay and the final product desired. This step of the process must be carefully controlled as too severe leaching can destroy the adsorptive properties developed.

Following activation, the slurry is thickened and washed with water to remove water soluble salts formed during activation as well as to remove residual mineral acid. For some applications, as in the decolorizing of soybean and linseed oils, it has been found desirable to leave a small amount of free mineral acid in the clay after leaching and washing. This free acid appears to assist in color adsorption. After being mechanically dewatered the clay is dried and pulverized in much the same manner as fuller's earth.



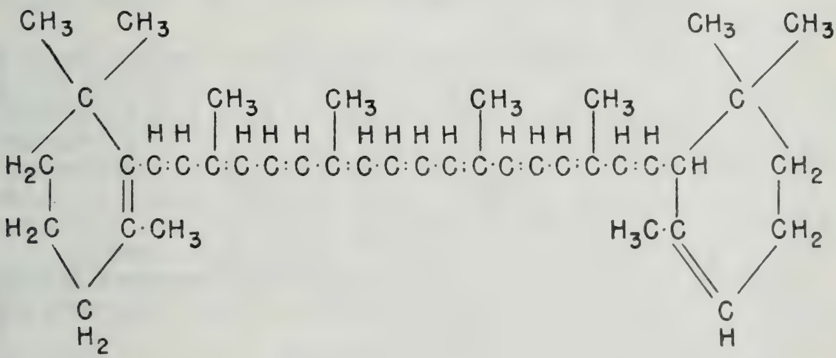
b- Carotene, $C_{40}H_{56}$

FIGURE 18. Molecular structure of b-carotene, $C_{40}H_{-6}$, a colorant found in many vegetable oils. *After Bodansky, 1938.*

Mantell (1951 p. 66) states, "Despite the fact that activating a bentonite clay by partial leaching with acid is one of the simplest chemical operations in theory, in practice it is one of the most difficult because of the extreme degree of control necessary to obtain the correct result for the requisite bleaching power."

PRICES AND METHODS OF DISTRIBUTION

Most adsorbent clays produced in California are packaged in 50-pound paper bags for shipment to the consumer. Some bulk shipments are also made. In 1952 prices ranged from approximately \$25 per ton for the less active grades of fuller's earth to as much as \$45 per ton for the more active fuller's earth. Acid treated clays are generally higher priced but much more efficient, which usually more than compensates for the additional initial cost. Prices of the activated clays ranged from \$45 to approximately \$80 per ton. The clays are sold either directly by the producers or through jobbers or sales representatives.



a - Carotene, $C_{40}H_{56}$

FIGURE 19. Molecular structure of a-carotene, $C_{40}H_{-6}$. *After Bodansky, 1938.*

USE IN THE OIL INDUSTRIES

Freundlich Adsorption Isotherm. Although fuller's earths and activated clays are used principally to decolorize oils, they are equally effective in removing other undesirable impurities from oils. It is now generally realized that the removal of undesirable constituents from oils by adsorption follows more or less closely the general adsorption isotherm of Freundlich which is mathematically expressed as follows (Freundlich, 1922):

$$x/m = C^n$$

where x = units of impurities removed,
m = quantity of adsorbent used,
C = equilibrium concentration of impurities in the oil,
k and n = constants, depending upon the nature of the adsorbent, substances adsorbed, the solvent, method of adsorbent addition, etc.

This equation also may be put into a logarithmic form:

$$\log x/m = \log k + n \log C$$

An examination of the equation in this form shows that plotting values of log x/m against log C should yield a straight line with a slope n that intersects the Y-axis at a point corresponding to log k. For the evaluation of various adsorbents k may be considered a general measure of the decolorizing or adsorbing power of the adsorbent.

The value of n gives an indication of the characteristic manner of adsorption. If n is high, the adsorbent will be good for removing the first portions of color but relatively poor for effecting a high degree of decolorization. If n is low the reverse will be true. In comparing two adsorbent clays having radically different n values it is necessary to specify the clay dosage at which the comparisons are made.

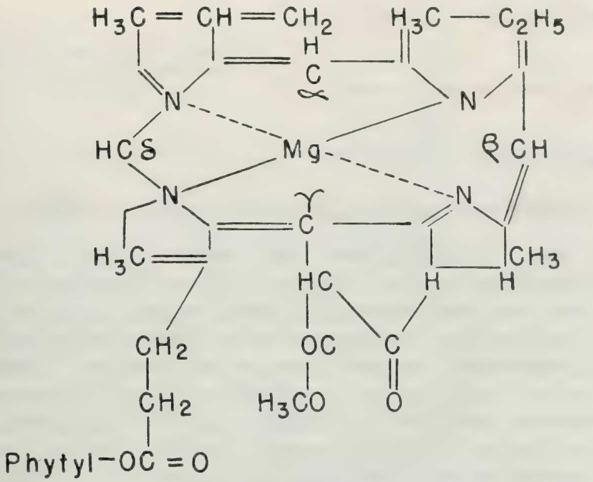
Relative decolorizing efficiencies at one level are not necessarily indicative of relative efficiencies at some other level or dosage. Freundlich adsorption isotherms for three clays used to decolorize soybean oil are shown in figure 17.

The Freundlich equation indicates that a clay which has reached equilibrium with respect to the pigments in a light-colored oil should still be able to adsorb from a darker oil. This fact is used advantageously in some industries, the decolorization of dark-colored microcrystalline waxes being a good example.

The Freundlich equation also indicates that the adsorbent should be more effective if applied in small increments than if applied all at once. However Odeen and Slossen (1948) found that in the open kettle bleaching of refined cottonseed oil with an activated clay the reverse was true. They found that more effective decolorization was accomplished in a single stage operation probably because oxidation during the longer time required for multistage bleaching prevented the over-all color decrease from equalling that attained by single stage bleaching.

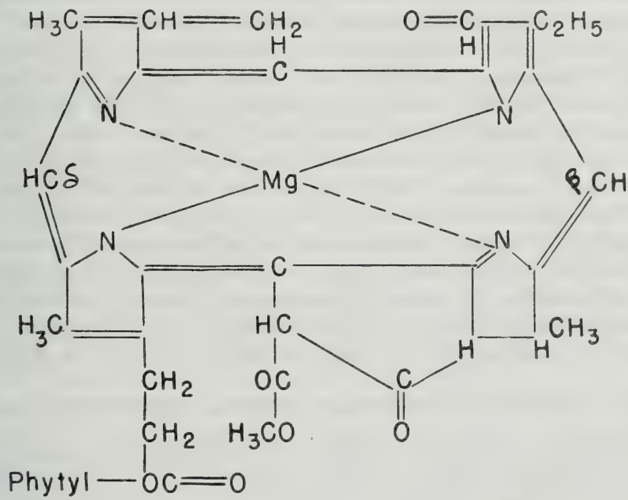
Bleaching does not always follow exactly the Freundlich equation probably because of variations in the amount of oxygen that reacts with the oils to produce colored materials.

These new colorants formed in oils during decolorization with adsorbent clays interfere with the validity of the adsorption isotherm and reduce the practical efficiency of adsorbents.



Chlorophyll (a) $C_{55}H_{72}O_5N_4Mg$

FIGURE 20. Molecular structure of a-chlorophyll, $C_{55}H_{22}O_5N_4$-Mg. *After Bodansky, 1938.*



Chlorophyll (b) $C_{55}H_{70}O_6N_4Mg$

FIGURE 21. Molecular structure of b-chlorophyll, $C_{55}H_{70}O_6N_4Mg$. *After Bodansky, 1938.*

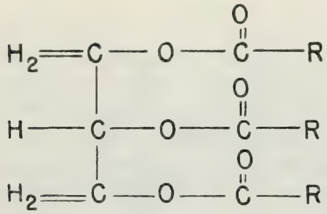


Figure 22. Generalized molecular structure of fat. *After Bodansky, 1938.*

PIGMENTS AND COLORANTS FOUND IN OILS

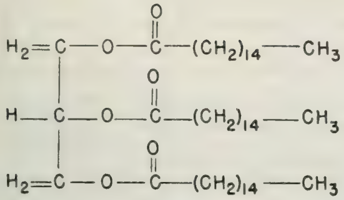
Vegetable Oils. Crude oils and fats contain various coloring materials in colloidal dispersion or in actual solution. The composition of the colorants is complex and extremely varied depending upon the oil. In most vegetable oils red and yellow colors are characteristic, and are due principally to carotenoid pigments such as carotene and to xanthophylls or to their isomeric and destruction products. The structures of a-carotene and b-carotene are shown in figures 18 and 19 (Bodansky, 1938, p. 577). Another pigment found in some vegetable oils that is effectively removed by means of activated clays and removed to a limited extent by fuller's earth is chlorophyll. The structures of its two isomeric forms are shown in figures 20 and 21 (Bodansky 1938, pp. 24-25).

Petroleum Oils. The colorants and other impurities found in petroleum oils and products are quite different from those present in vegetable oils and fats. However the general methods of using adsorbent clays for purifying these two types of oils are very similar. Kalichensky and Stagner (1942), in an excellent summation of the general nature of petroleum products and their purification by adsorption state that in petroleum products as a general rule, the unsaturated hydrocarbons are the most readily adsorbed, the aromatics next, the naphthenes third and the paraffins least. Adsorption within the same general class of hydrocarbons increases with increasing molecular weight and complexity, a fact known as Traube's rule (Hassler, 1941). Resinous and asphaltic substances are strongly reactive towards adsorbents and adsorbent clays are highly effective in removing pitchy materials from cracked oils. One type of fuller's earth will adsorb up to 12 percent of its weight of this type of substance. These materials are usually dark-colored (Gurwitsch, 1934).

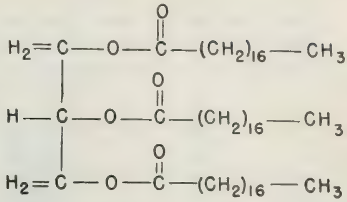
Kalichensky and Stagner also state that fuller's earths and activated clays are effective in removing sulfur, nitrogen and oxygenated compounds as well as strongly acidic substances such as sulfuric and sulfonic acids and acid sludges from oils. Gum-forming constituents of light oils are removed by passing the oil vapors through a bed of fuller's earth.

PURIFICATION OF VEGETABLE, ANIMAL AND MARINE OILS

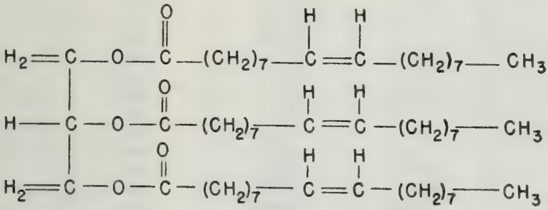
Chemical Nature and Uses of Oils. Oils of this type are with few exceptions triglycerol esters of fatty acids and are known within the industry as fats. The molecular structure of a fat is represented in figure 22. In figure 23 are shown structural formulae for tripalmitin, triolein and tristearin, fats found in most vegetable oils. Petroleum oils are composed principally of hydrocarbons, and the natural pigments and colorants found in fats and in petroleum oils are quite different. Fats



Tripalmitin



Tristearin



Triolein

FIGURE 23. Structure of common fats found in various oils. *After Bodansky, 1938.*

are used for both edible and inedible purposes. The principal edible uses are salad and cooking oils, oleomargarine, shortening, etc. The principal inedible uses are paint and varnishes, raw materials for resin manufacture, linoleum and oil cloth, ingredients, transformer oils, cutting oils for metal machining, leather and textile industries, cosmetics, candles, raw materials for fatty acid manufacture, pharmaceuticals and germicides, tin-plating and in the manufacture of soap and detergents.

Fats are treated with adsorbent clays either in the crude or raw state or after the fat has been alkali- or acid-refined. Acid refining has been largely discontinued in this country because of deleterious effects upon oil stability. Oils to be used for edible purposes are almost always alkali refined before treatment with adsorbent clays. Inedible oils may or may not be alkali refined prior to clay treatment.

Alkali refining, a process in which the oil is intimately mixed with either potassium of sodium hydroxide or other caustic materials, effectively removes most of the colloidal and acidic materials from oils. In the refining process the alkali is mixed with the oil, allowed to react, and the resultant soaps and sludge separated from the oil either by settling or centrifuging followed by washing with hot water. This process removes much of the color and other impurities and renders the oil more amenable to further decolorization by treatment with adsorbent clays. Bailey (1945) has provided a complete description of alkali refining processes.

Clay treatment is usually performed in kettles of sufficient capacity to hold half a tank car or 30,000 pounds of fat. The kettles are equipped with steam coils for heating and with mechanically driven, paddle-type agitators. The kettles may be open at the top for bleaching the oil while directly exposed to the atmosphere or may be completely enclosed for bleaching under vacuum or in some neutral atmosphere. Generally atmospheric bleaching is the least effective because of side reactions such

Table 9. Optimum decolorizing conditions for various vegetable oils when treated with a particular grade of activated clay. Data from Standard Pamphlet No. 401, of the Filtrol Corporation, Los Angeles, California.

Oil	Normal clay dosage (percent)	Top decolorizing temperature		Time at top decolorizing temperature
		Atmospheric	Vacuum	
Babassu	½–2	230° F	180	20 min.
Castor	1–3	220	180	"
Cocoa Butter	¼–2	230	180	"
Coconut	¼–2	230	180	"
Corn	¼–3	220	180	"
Cottonseed	½–3	220	180	"
Linseed	1–2	190	170	"
Oiticica	1–5	200	180	"
Palm Kernel	½–2	230	180	"
Palm	3–5	325	325	"
Peanut	½–2	220	180	"
Perilla	1–2	190	180	"
Rapeseed	1–3	220	180	"
Sesame	1–2	200	170	"
Soybean	½–3	220	180	"
Sunflower	½–3	220	180	"
Tall	2–25	150–200	180	"
Tung	1–5	. .	180	"

Speed of agitation, 50-100 R.P.M.; degree of agitation, strong but not violent; temperature of oil when adding adsorbent, atmospheric (160° F.); vacuum temperature of oil when tank is filled with 28" water, minimum.

as oxidation and polymerization which create new colorants in the oils during the decolorizing operation.

In practice the oil is added to the kettle, heated to approximately 80 to 120° C. either atmospherically or vacuumerically, depending upon the oil and equipment available, and held for 15-20 minutes to remove moisture. The adsorbent clay is then added and intimately mixed with the oil by means of the mechanical agitator. This contacting is continued just long enough to insure complete elimination of moisture introduced by the clay, complete contacting of the clay particles with the oil, and attainment of adsorption equilibrium between the clay and oil. Ordinarily contact times of from 20 minutes to 2 hours are used. Longer contact times are to be avoided because the oil will tend to oxidize, revert, or develop new colors and become rancid. The oil is then filtered to remove the spent clay and adsorbed colors and other impurities.

Contact Temperature. The contact temperature for optimum color removal will vary and depends upon the oil, the adsorbent, the equipment and the method of handling. For most vegetable oils the activated clays show a temperature of maximum activity in the range 100°-106° C. The natural clays show maximum activity in the range 118°-132° C. Bleaching in vacuum requires lower contact temperatures than atmospheric bleaching. Generally 180° F. is used for vacuumeric bleaching. In table 9 are shown decolorizing conditions considered by one manufacturer to be optimum for various vegetable oils when treated with a particular grade of activated clay.

Pigment or Color Removal. Many of the various pigments found in oils can be identified by spectral transmittance measurements (O'Connor, Field, Jefferson, and Dollear, 1949.) By determining the spectral transmittance of an oil before and after treatment with an adsorbent

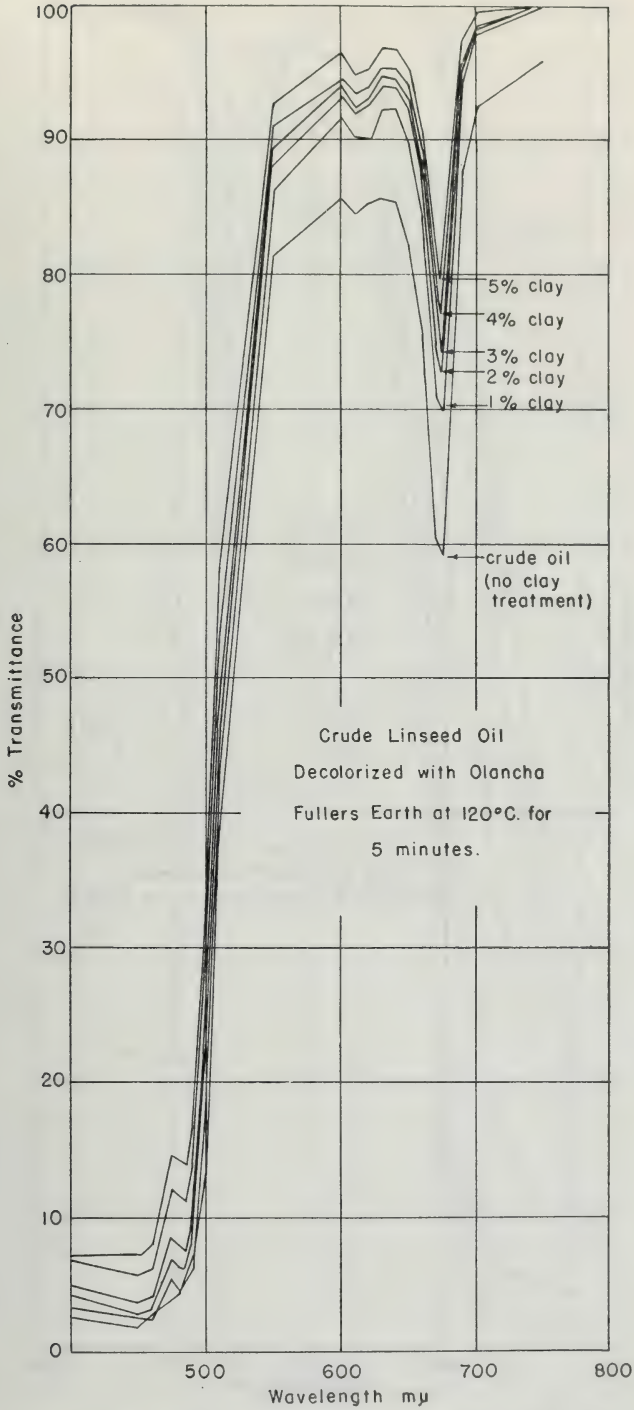


FIGURE 24. Changes in the spectral transmittance of a sample of linseed oil after treatment by alkali refining and by decolorization with adsorbent clay.

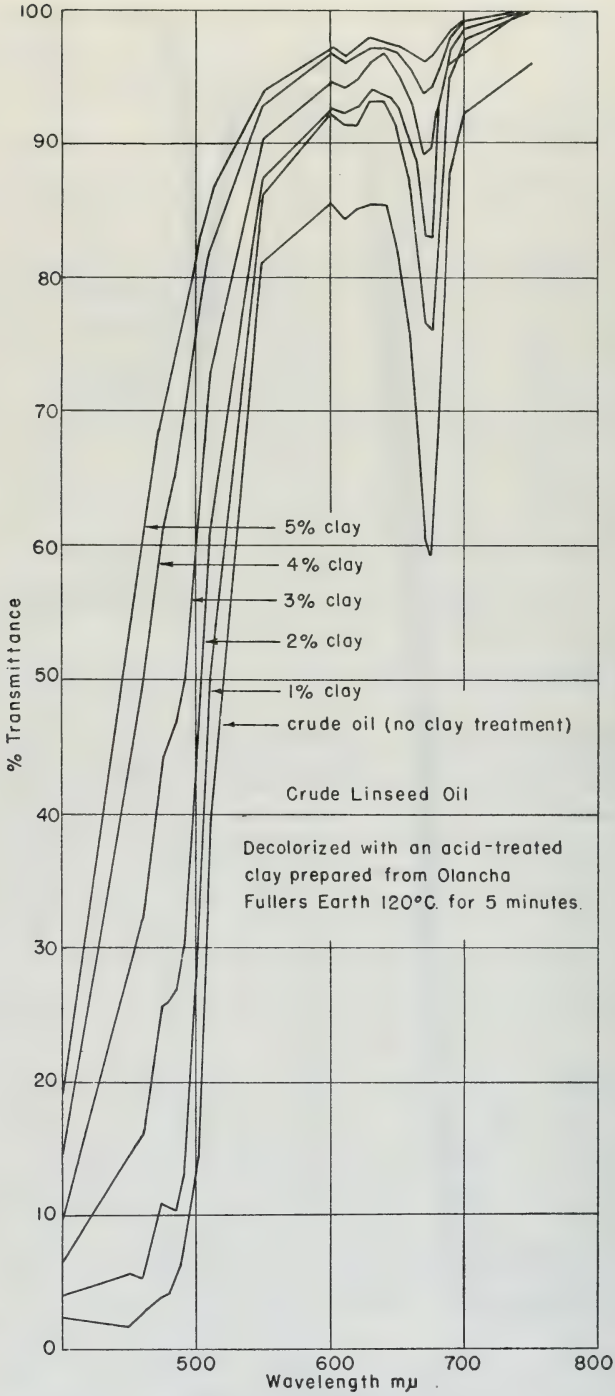


FIGURE 25. Changes in the spectral transmittance of a sample of linseed oil after treatment by alkali refining and by decolorization with adsorbent clay.

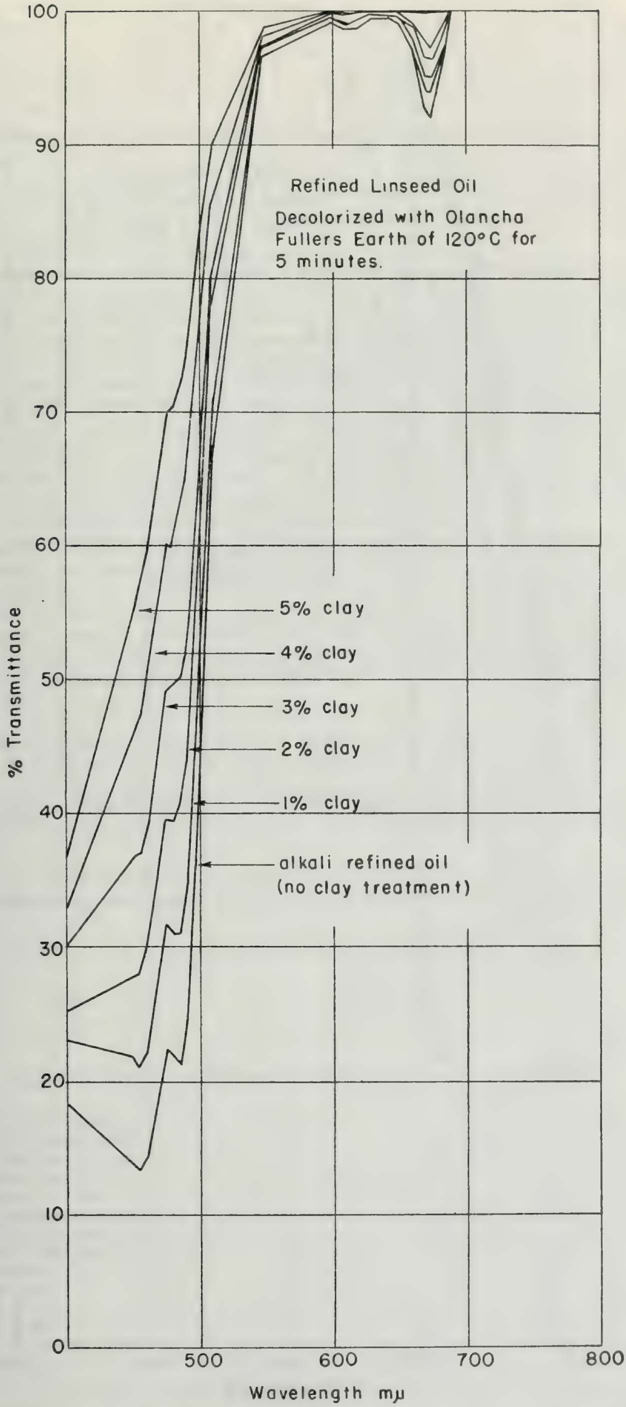


FIGURE 26. Changes in the spectral transmittance of a sample of linseed oil after treatment by alkali refining and by decolorization with adsorbent clay.

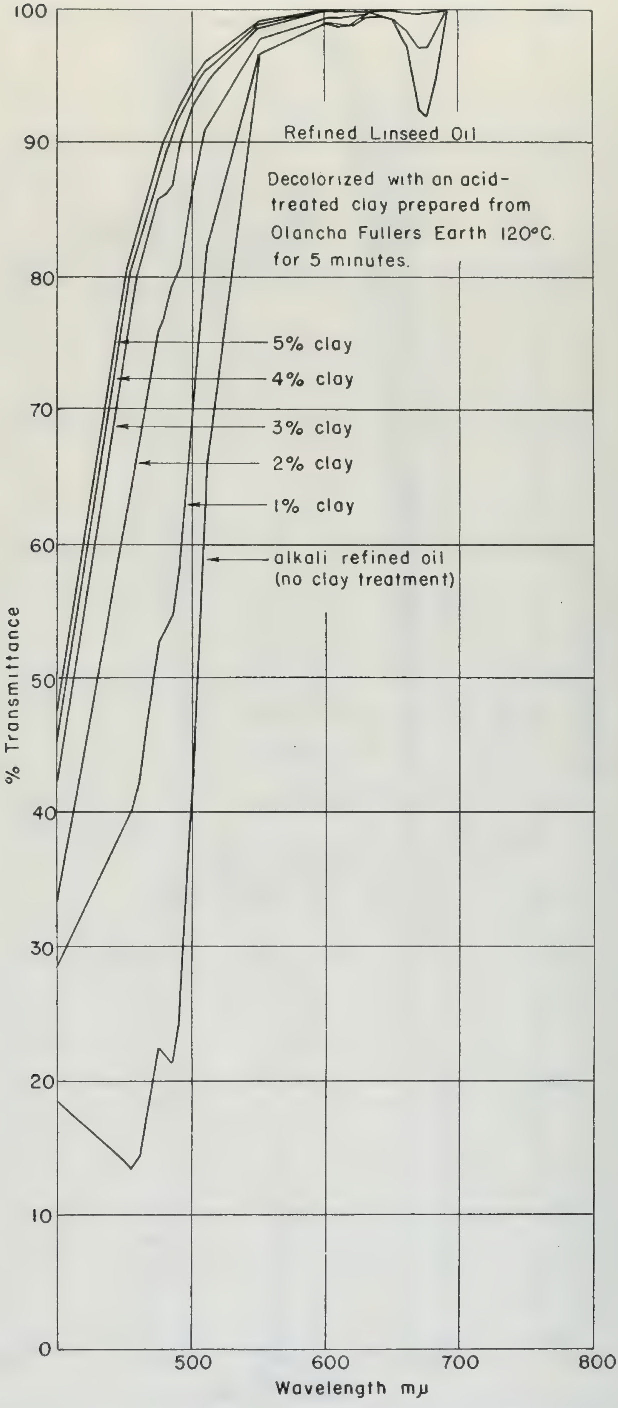


FIGURE 27. Changes in the spectral transmittance of a sample of linseed oil after treatment by alkali refining and by decolorization with adsorbent clay.

clay it is possible to determine the pigments in the oil prior to treatment and to determine the type and amount of each pigment removed. Figure 24 shows the spectral transmittance of a crude linseed oil, the same oil after alkali-refined, and the same oil after decolorization with Olancha fuller's earth and with an activated clay prepared from Olancha fuller's earth. These spectral transmittance curves were obtained using a Beckman DU spectrophotometer and 1.000 cm cells. Distilled water was used as a reference of 100 percent transmittance at each wave length. These figures illustrate the following:

(1) The various irregularities and dips in the curves at different wavelengths are indicative of maximum adsorption bands for the different pigments and colorants present in the oil. For example the very pronounced dips in the curves at 610 and 670 millimicrons are due to the presence of pheophytin A. Pheophytin A is formed when chlorophyll undergoes decomposition by the loss of magnesium. The carotenoids show adsorption bands at 445 and 475 millimicrons. The amplitude of these dips and irregularities is relative to the amount of colorant present. By tracing the changes in transmittance at these various wavelengths it is possible to follow the removal of colorants by treatment of the oil with adsorbent clay.

(2) This particular linseed oil contained a substantial amount of the green pigment pheophytin A as well as yellow and red pigments. Alkali refining removed a large amount of both yellow and red as well as green pigment.

(3) Treatment of both the crude and alkali refined oils with both fuller's earth and acid treated clay removed large quantities of color. Notice the elimination of the irregularities in the curves between 450 and 500 millimicrons and the gradual elimination of the dips at 610 and 670 millimicrons as the clay dosage is increased. The curves also show the marked superiority of the activated clay over the fuller's earth. For example, 5 percent of the fuller's earth was required to remove the pheophytin A completely from the refined oil. Only 2 percent activated clay was required for the same function.

Removal of Other Impurities. Although color removal is the main function of adsorbent clays, yet they are useful in the removal, by adsorption, of other impurities. For example, oils which have been alkali refined still contain traces of soap even after washing and centrifuging.

Table 10. Removal of soap and peroxide by clays from refined cottonseed oil.

Type of clay	Percent clay used	Soap content (ppm. $NaOOCC_{17}H_{33}$)		Peroxide content (peroxide number)	
		Before treatment	After treatment	Before treatment	After treatment
A.O.C.S. standard natural clay	1	22	6	8.20	11.36
A.O.C.S. standard natural clay	2	22	4	8.20	11.36
A.O.C.S. standard natural clay	2	210	130	1.01	1.24
A.O.C.S. standard natural clay	4	210	102	1.01	1.91
A.O.C.S. standard activated clay	1	22	none	8.20	4.63
A.O.C.S. standard activated clay	2	22	none	8.20	2.47
A.O.C.S. standard activated clay	2	210	39	1.01	0.00
A.O.C.S. standard activated clay	4	210	none	1.01	0.00
Olancha fullers earth	1	22	none	8.20	8.80
Olancha fullers earth	2	22	none	8.20	9.45
Olancha fullers earth	2	210	35	1.01	1.14
Olancha fullers earth	4	210	0	1.01	1.72
Acid treated clay prepared from Olancha fullers earth	1	22	none	8.20	2.69
Acid treated clay prepared from Olancha fullers earth	2	22	none	8.20	2.03
Acid treated clay prepared from Olancha fullers earth	2	210	7	1.01	0.00
Acid treated clay prepared from Olancha fullers earth	4	210	none	1.01	0.00

This soap, if allowed to remain in the oil, can have a deleterious effect on the stability of the oil. Also soap traces are powerful catalytic poisons and interfere with hydrogenation if the oil is to be used in making oleomargarine or shortening. Such soap traces also interfere with the boiling or heat bodying of paint oils. Many adsorbent clays and especially the activated clays effectively remove the soap. Table 10 illustrates soap removal from two different samples of refined cottonseed oil using four different types of clay.

Adsorbent clays are also effective in removing peroxides from oils. Peroxides are formed in oils as an initial stage of rancidity development due to oxidation. Their removal with clay temporarily halts the development of rancidity and is of value in the processing of edible oils. Adsorbent clays also show a strong affinity for the natural anti-oxidants found in oils. For this reason many clay treated oils are less stable than the natural or untreated oil. Table 10 shows the removal of peroxides from the same two samples of refined cottonseed oil by treatment with adsorbent clay. These results indicate that only the acid treated clays are effective in removing peroxides and that the fuller's earths can actually promote the development of peroxides or rancidity. This is an important consideration in the processing of edible oils.

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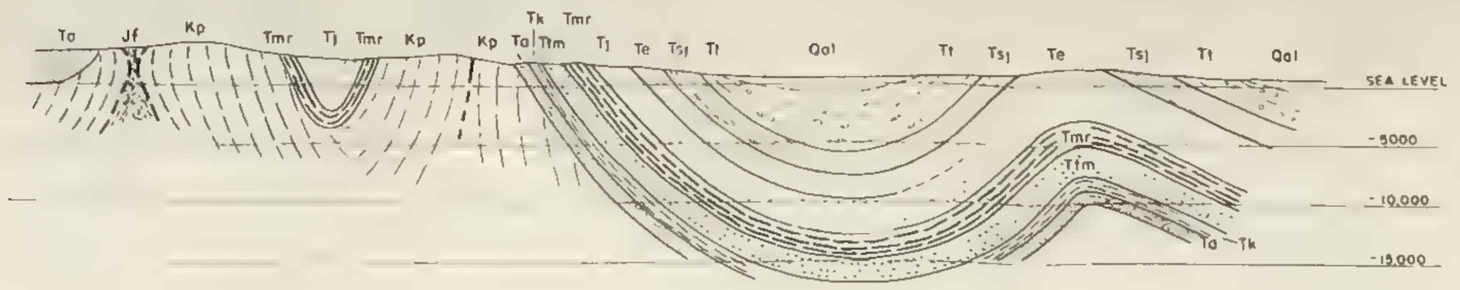
GEOLOGIC MAP OF KINGS COUNTY, CALIFORNIA SHOWING MINES AND HOLES DRILLED FOR OIL AND GAS

SCALE

0 1 2 4 6 8 10 MILES

Source of geologic data
Stewart, U S G S Prof Paper 205C
Woodring, Stewart and Richards, USGS PP 195
Bailey, U S G S Bull 936
Arnold and Anderson, U S G S Bull 398
Herrero, Unpub thesis Univ Calif
Clark, G S A 1935



GENERALIZED CROSS SECTION ACROSS SOUTHWESTERN KINGS COUNTY
(MODIFIED AFTER STEWART, WOODRING, STEWART & RICHARDS, HERRERA

WELLS DRILLED FOR OIL AND GAS

Map number	Name of property or well	Sec.	T	R.
1	Arthur C Fisher Jim 1	34	17S	21E
2	Texas So The Souza 14 33	33	17S	22E
3	Shell Oil Co Fresno Slough Unit 1 1	1	18S	19E
4	Tide Water Assoc Gomes & Silveira 8 13	13	18S	20E
5	Getty Geo F Grangeville Community 1	27	18S	20E
6	Lake Oil Co Blanchard 2	22	18S	22E
7	Lake Oil Co M P M Phillips 1	35	18S	22E
8	Goshen Syndicate Drummond Union 1	36	18S	22E
9	Goshen Syndicate Drummond Union 2	36	18S	22E
10	Goshen Syndicate Drummond Union 3	36	18S	22E
11	Arcady Oil Co Drummond Union 1	36	18S	22E
12	Continental Oil Co Drummond 2	36	18S	22E
13	Oilfield Equipment & Supply Co Drummond Union 1 5	36	18S	22E
14	Turner & Goldsberry Goldminer 1	8	18S	23E
15	Independent Exploration Co Bennet Smith 52	31	18S	23E
16	Shell Oil Co Boston Land Co D	17	19S	19E
17	Justice & Elerby No 1	27	19S	19E
18	Southern California Petroleum Corp Socal Bergen 88 32	32	19S	20E
19	Seaboard Oil Co of Delaware Seaboard Continental 66 2	2	19S	22E
20	Standard Oil Co Mills 58 8	8	19S	22E
21	Harry S Sankey Rockhold 1	6	19S	23E
22	General Petroleum Corp B & C 48 7	7	20S	19E
23	California Natural Gas & Development Co No 1	24	20S	20E
24	Pacific Oil & Gas Co No 2	24	20S	20E
25	Stone Glen G Teeter 1	25	20S	20E
26	Stone Glen C Teeter 1	25	20S	20E
27	Harp & Brown Corcoran Irrigation 1	21	20S	22E
28	Western Gulf Oil Co C I D 25 1	25	20S	22E
29	Pennsylvania Western Oil Co No 1	24	21S	18E
30	Little Chief Oil Co No 1	33	21S	19E
31	General Petroleum Corp Richardson 36 4	4	21S	21E
32	Monocline Development Co Norell F G No 1 or Guess 1 (?)	7	21S	21E
33	Guess 1	7	21S	21E
34	Tide Water Associated Cohn Est 6 4	4	22S	19E
35	Milham Exploration Co West Tulare 1	5	22S	19E
36	Sunray Oil Corp Westlake Farms 1136 13	13	22S	19E
37	Rowan Oil Co Crocket & Gambogy 1	9	22S	20E
38	Commonwealth Consolidated Gas Ltd No 1	21	22S	20E
39	Commonwealth Consolidated Gas Ltd No 2	21	22S	20E
40	Union Oil Co Hancock Union Giannini 1	28	22S	20E
41	Shell Oil Co Inc Tulare Lake 21 28	28	22S	20E
42	Yarrow Helen No 1	32	22S	20E
43	Woodward Glenn No 1	32	22S	20E
44	Hancock Oil Co Crocket & Gambogy 23 33	33	22S	21E
45	Milham Oil Co No 1	20	22S	22E
46	Shell Oil Co Inc Salyer 3 1	30	22S	22E
47	Shell Oil Co Inc Crow 41 2	2	23S	16E
48	Kettleman Reef Ridge Oil Co No 1	10	23S	16E
49	Hiratsuka Shigeki 2	10	23S	16E
50	Chuka Oil Co et al 2A	10	23S	16E
51	Chuka Oil Co et al 2	10	23S	16E
52	Reef Ridge Oil Co Well 1	10	23S	16E
53	Reef Ridge Oil Co Well 2	10	23S	16E
54	Easterbrooks 3 F 1	11	23S	16E
55	Weller Carl W Baby King 2	11	23S	16E
56	Baby King 3	11	23S	16E
57	Weller Carl W Baby King 2	11	23S	16E
58	Blair Oil Co Blair 1B	24	23S	16E
59	Blair George No 1	24	23S	16E
60	Birch Ranch & Oil Co Orr 1	5	23S	17E
61	Sunray Oil Corp Lynch Mauren 68 9	9	23S	17E
62	Barnsdall Oil Co Lynch Mauren 88 9	9	23S	17E
63	Big Tar Canyon Oil Co No 1	18	23S	17E
64	Kings Exploration Co Avenal 1	18	23S	17E
65	British American Oil Producing Co The Avena 86 31	31	23S	17E
66	Associated Oil Co Avena 1	35	23S	17E
67	Associated Oil Co Avenal 2	35	23S	17E
68	Whitely & Van Antwerp No 1	35	23S	17E
69	O M Slosson Reserve 1	35	23S	17E
70	O M Slosson Reserve 2	35	23S	17E
71	Knudsen & Schmidt No 1	36	23S	17E
72	Harris Investment Corp Thunderbird 1	30	23S	18E
73	S & G Mutual Oil & Gas Development Assn Morris 1	30	23S	18E
74	Triumne Oil Gas & Light Co No 1	5	23S	20E
75	California Oil Co No 1	7	23S	20E
76	O Donnel Gas Co Ltd Dudley Ridge 2	7	23S	20E
77	Irma Investment Corp Watson 2	7	23S	20E
78	Standard Oil Co Wishon Watson Co 32	7	23S	20E
79	Dudley Dome Oil & Gas Co No 1	9	23S	20E
80	Dudley Dome Oil & Gas Co No 2	9	23S	20E
81	Pacific Oil & Gas Co No 2	13	23S	20E
82	Eagle Oil & Gas Co No 1	15	23S	20E
83	Eagle Oil & Gas Co No 2	15	23S	20E
84	Valley Exploration Co Ltd Brennan 1	20	23S	20E
85	Dudley Ridge Development Co Josephine 1	24	23S	20E
86	Dudley Ridge Development Co Josephine 2	24	23S	20E
87	Standard Oil Co Machroth 1	28	23S	20E
88	Graphic Oil Corp Taylor 1	34	23S	20E
89	Magee Harry H operator Von Glahn 2 1	2	23S	21E
90	Western Gulf Oil Co 14 8 Von Glahn	8	23S	21E
91	Shell Oil Co Harvester Unit 1 1	11	23S	21E
92	Shell Oil Co Mortgage Service Co 1	13	23S	21E
93	Pacific Oil & Gas Co No 1	18	23S	21E
94	Standard Oil Co of California Mortgage Guarantee Community 1	25	23S	21E
95	Elmer C Von Glahn 1	4	23S	22E
96	Kings County Oil Co 2 Elmer C Von Glahn 1	4	23S	22E
97	Tri Counties Oil Co Olson 1	10	23S	22E
98	Tri Counties Oil Co 1 Olson 1	10	23S	22E
99	California Natural Gas & Development Co No 1	12	23S	22E
100	California Natural Gas & Development Co No 2	12	23S	22E
101	California Natural Gas & Development Co No 3	12	23S	22E
102	California Natural Gas & Development Co No 4	12	23S	22E
103	Dudley Petroleum Co (B B & E R) No 1	12	23S	22E
104	Guess E B Guess 2	12	23S	22E
105	Sunray Oil Corp Mary Ann Richardson 1	13	23S	22E
106	Magee Harry H operator Von Glahn 17 1	17	23S	22E
107	Standard Oil Co of Calif, Cutter 2	29	23S	22E
108	Standard Oil Co Cutter Unit 3	29	23S	22E
109	Standard Oil Co of Calif Hughes 1	30	23S	22E
110	Standard Oil Co of Calif Von Glahn Unit 3	34	23S	22E
111	Welport Oil Co Avenal 1	9	24S	17E
112	Dial Glen Miller 1	13	24S	17E
113	Miesse Richard S Jackie 1	22	24S	17E
114	Chanslor-Canfield Midway Oil Co Orchard 1	25	24S	17E
115	Richardson Guy Holtz & Zennelli 1	8	24S	18E
116	Fiske J H H G Spengler Trustee and Henry R Dabney Core Hole F S D 2	8	24S	18E
117	Dohm Oil Co Fairco 1	8	24S	18E
118	T M Pope Eagle 1	8	24S	18E
119	Alva McPhail & Roy Gil McPhaill 1	14	24S	18E
120	Royalty Service Corp Ltd Spreckles 1	16	24S	18E
121	Pyramid Production Co Spreckles 2	16	24S	18E
122	Glen H Mitchell & Mitchell Co Mitchel Lucier 1	19	24S	18E
123	Barnes Core Drilling Co Lucier 2	19	24S	18E
124	Pyramid Production Co Retherford 1	27	24S	18E
125	Pacific Oil & Gas Development Corp Hand 35 28	28	24S	18E
126	Pacific Oil & Gas Development Corp Sharp 76 28	28	24S	18E
127	Norris Oil Co Well 1	28	24S	18E
128	Norris Oil Co Well 18 28	28	24S	18E
129	Norris Oil Co Well 116 28	28	24S	18E
130	Norris Oil Co Well 114 28	28	24S	18E
131	Norris Oil Co Well 115 28	28	24S	18E
132	Nelson B Cramer Dolly 1	28	24S	18E
133	Buaas Development Co Deming 1	29	24S	18E
134	Norris Oil Co Hand 2	29	24S	18E
135	Norris Oil Co Hand 1	29	24S	18E
136	Tide Water Associated Oil Co Orchard 56	30	24S	18E
137	General Petroleum Corp McRae 1	34	24S	18E
138	Standard Oil Co Kettleman 1	34	24S	18E
139	South Dome Oil Co Clarence G Smith 1	35	24S	19E
140	Clarence G Smith 1	35	24S	19E
141	Bisconer Raymond J Dudley Kettleman Gas & Oil Co 12	11	24S	20E
142	Bisconer Raymond No 1	11	24S	20E
143	Shell Oil Co Inc La Hacienda 1	12	24S	20E
144	Shell Oil Co No 2	19	24S	21E
145	Shell Oil Co No 1	22	24S	21E
146	Magee & Stone No 2	33	24S	22E
147	Trico Oil & Gas Co No 1	33	24S	22E
148	Magee & Stone No 1	34	24S	22E
	FULLER'S EARTH			
149	Edward A Webb & S M Mingus	26	21S	17E
	GYPSITE			
150	Avenal Gap	2 3, 11	24S	18E
151	McPhaill Gypsum Company	14	24S	18E
152	Tulare Lake View group	26 35 36	21S	17E
153	C E Boyd	13	24S	17E
	MAGNESITE			
154	Kings Magnesite Company	20	23S	16E
	QUICKSILVER			
155	Fredana Kings)	20	23S	16E
156	Dawson	28	23S	16E
157	Fairview and French Avaloch group	28	23S	16E
158	Canyon	22	23S	16E

EXPLANATION

QUAT	Recent	Qal	Alluvium	
		Qlb	Lake bed deposits	
	Plio-Pleist	Tt	Tulare formation, sand, clay, conglomerate	
TERTIARY	Pliocene	Tsj	San Joaquin formation, clay	
		Te	Etchegoin formation, sandstone	
		Tj	Jacalitos formation, sandstone	
	Miocene	Tmr	McLure shale and Reef Ridge shale	
		Tfm	Temblor formation, sandstone	
	Eocene	Tk	Kreyenhagen formation, shale	
		Ta	Avenal formation, sandstone	
CRET	U Cret	Kp	Panoche formation, sandstone, shale	
UPPER JURASSIC(?)		sp	Serpentine	Franciscan group
		Jf	Sandstone, shale, chert and greenstone	Franciscan group

Contact (dashed where approximate)

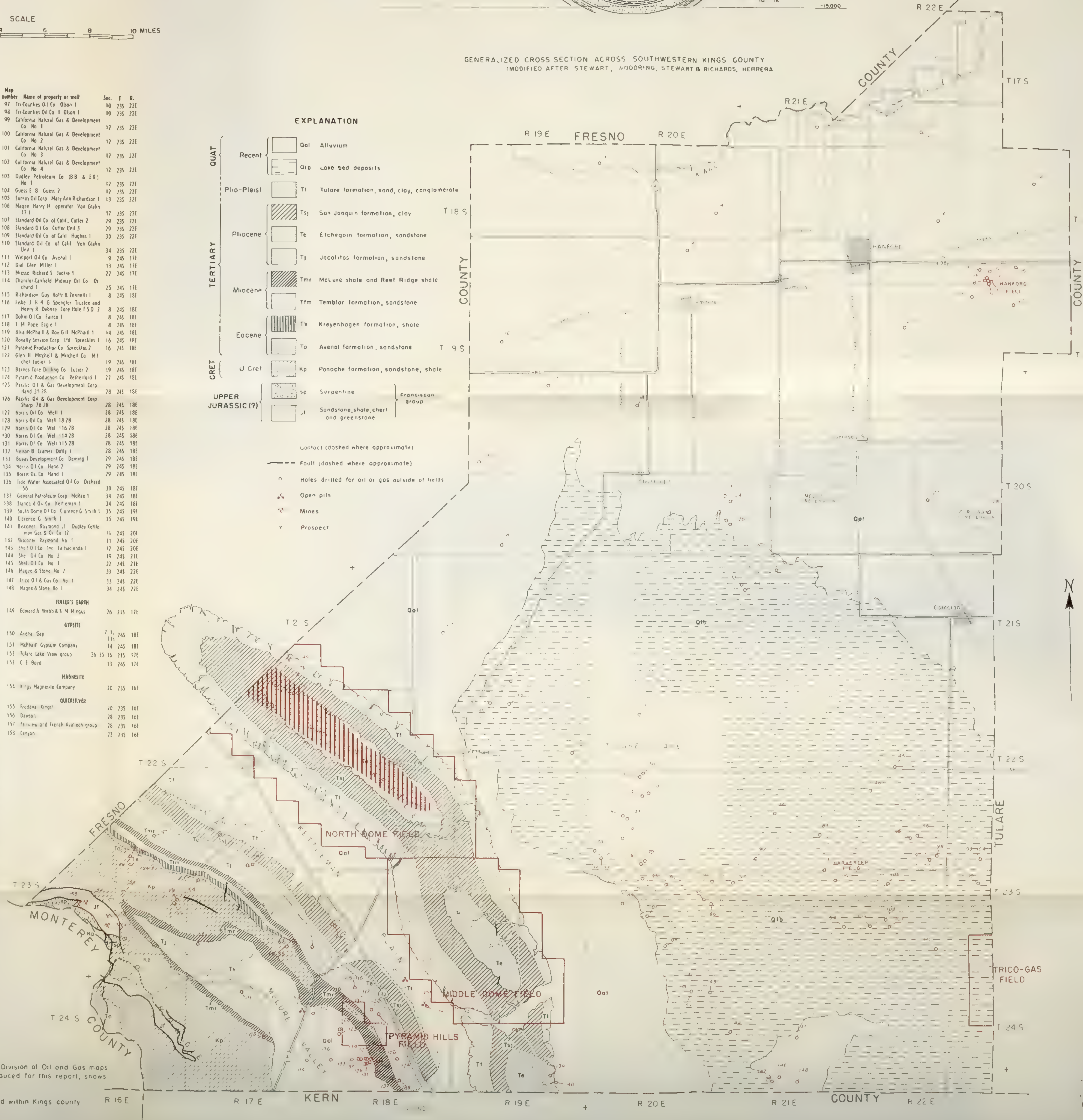
Fault (dashed where approximate)

Holes drilled for oil or gas outside of fields

Open pits

Mines

Prospect



Boundary of oil fields as shown on Division of Oil and Gas maps Map No 36, Kettleman Hills, reproduced for this report, shows locations of wells drilled therein

Producing area of North Dome field within Kings county

STATE OF CALIFORNIA
GOODWIN J. KNIGHT, Governor
DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO 11
OLAF P. JENKINS, Chief

Vol. 49 OCTOBER 1953 No. 4

CALIFORNIA JOURNAL OF MINES AND GEOLOGY

STATE OF CALIFORNIA
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DEPARTMENT OF NATURAL RESOURCES
DeWitt Nelson, Director

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In addition to oral conferences in the offices of the Division of Mines, information concerning the mineral resources, mineral industry, geology, and mining operations of California is distributed to the public by means of publications, monthly releases, and letters. Each letter of inquiry received by the Division is answered by the technical staff member best qualified to do so.

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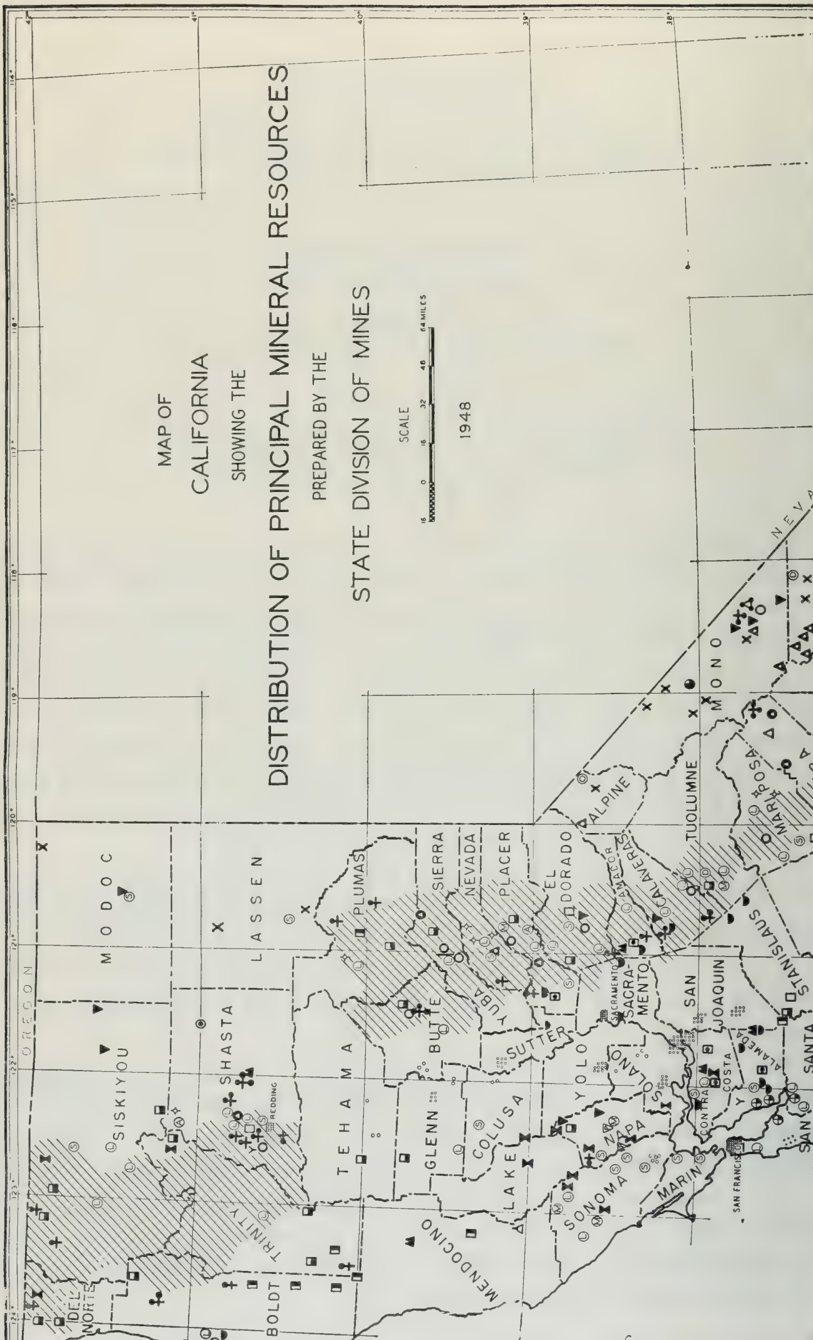
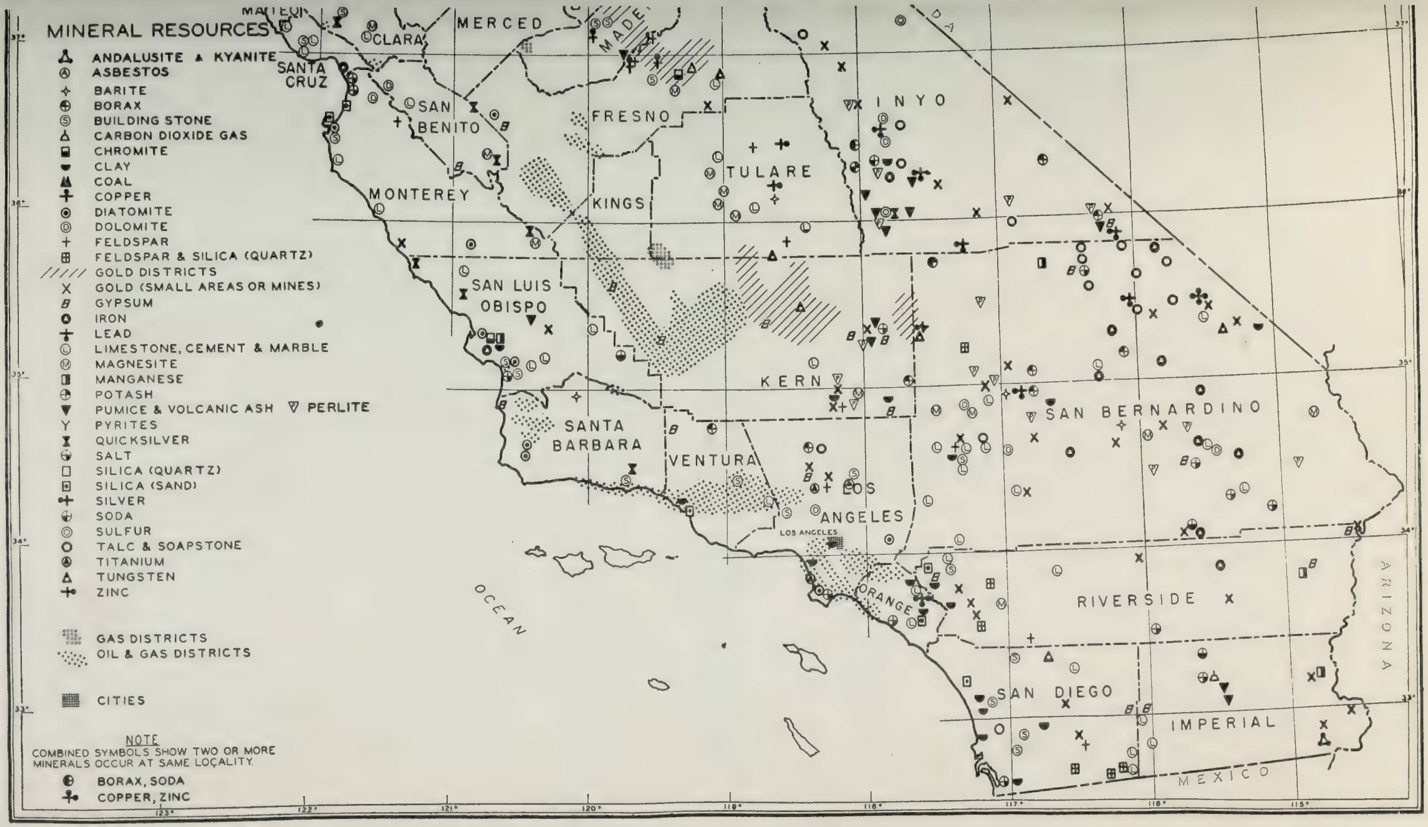

MAP OF
CALIFORNIA
SHOWING THE
DISTRIBUTION OF PRINCIPAL MINERAL RESOURCES
PREPARED BY THE
STATE DIVISION OF MINES
SCALE
16 0 16 32 48 64 MILES
1948
OREGON
NEVA
PACIFIC
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
REDDING
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
PLACER
YUBA
COLUSA
SUTTER
EL DORADO
LAKE
YOLO
SACRAMENTO
SACRA-MENTO
AMADOR
ALPINE
CALAVERAS
TUOLUMNE
MONO
SONOMA
NAPA
SOLANO
SAN JOAQUIN
MARIPOSA
STANISLAUS
MARIN
CONTRA COSTA
ALAMEDA
SAN FRANCISCO
SANTA
SAN


MINERAL RESOURCES
ANDALUSITE & KYANITE
ASBESTOS
BARITE
BORAX
BUILDING STONE
CARBON DIOXIDE GAS
CHROMITE
CLAY
COAL
COPPER
DIATOMITE
DOLOMITE
FELDSPAR
FELDSPAR & SILICA (QUARTZ)
GOLD DISTRICTS
GOLD (SMALL AREAS OR MINES)
GYPSUM
IRON
LEAD
LIMESTONE, CEMENT & MARBLE
MAGNESITE
MANGANESE
POTASH
PUMICE & VOLCANIC ASH
PERLITE
PYRITES
QUICKSILVER
SALT
SILICA (QUARTZ)
SILICA (SAND)
SILVER
SODA
SULFUR
TALC & SOAPSTONE
TITANIUM
TUNGSTEN
ZINC
GAS DISTRICTS
OIL & GAS DISTRICTS
CITIES
NOTE
COMBINED SYMBOLS SHOW TWO OR MORE MINERALS OCCUR AT SAME LOCALITY.
BORAX, SODA
COPPER, ZINC
SANTA CRUZ
CLARA
MERCED
SAN BENITO
FRESNO
MONTEREY
KINGS
TULARE
INYO
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
LOS ANGELES
SAN BERNARDINO
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL
ARIZONA
MEXICO
OCEAN
37°
36°
35°
34°
33°
123°
122°
121°
120°
119°
118°
117°
116°
115°

CONTENTS

PLATES

MINES AND MINERAL RESOURCES OF MENDOCINO COUNTY, CALIFORNIA

By J. C. O'Brien *

OUTLINE OF REPORT

Illustrations

ABSTRACT

Mendocino County, situated in the northern Coast Ranges and bordering on the Pacific Ocean, is almost entirely underlain by argillaceous sandstone, conglomerate, chert, shale, and other rocks of the Franciscan group. A belt of Cretaceous conglomerate, sandstone, and shale about 10 miles wide crops out along the coast, and small remnants of Cretaceous and Tertiary sedimentary formations are found in the interior. Sill-like sheets of serpentine are intrusive into the upper part of the Franciscan group and the lower part of the Knoxville formation. Lumbering is the principal industry and accounts for ninety percent of the manufacturing employment in the county. Lumber production amounted to 367,000,000 board feet in 1948 when 124 mills were in operation. The main item produced is redwood sawlogs. Food processing, principally of wines and dairy products and commercial fishing are important industries. Agricultural production, livestock and poultry raising, crops of fruit, grapes, vegetables, melons and berries were valued at $15,181,000 in 1948.

* District mining engineer, California State Division of Mines, Redding, California.

The value of the total recorded mineral production for the county from 1880 to 1950 amounts to $4,391,105. The production of sand and gravel for use as concrete aggregate and for building and repairing roads is the principal mining industry; next in importance is the production of natural carbon-dioxide gas from wells drilled east of Hopland. Small lenses of chromite in serpentine were mined in World War years. Mendocino County was one of the leading California producers of high-grade lump manganese ore in World War I. Lenses of manganese oxides, carbonates and silicates are interbedded with chert in the Franciscan formation. Extensive deposits of a good grade of sub-bituminous coal occur in the middle Miocene formations east of Dos Rios but competition with petroleum, natural gas, and hydro-electric power has discouraged their development. Sandstone saturated with petroleum residues crops out in the Point Arena area and seven exploratory holes have been drilled and abandoned. Mineral springs, whose water is said to be helpful in the treatment of muscular ailments and digestive disorders, have been developed and resorts built in conjunction with them. Small recorded production of other minerals includes bituminous rock, brick clay, gold, limestone, magnesite, natural gas, platinum, quicksilver and silver.

INTRODUCTION

Mendocino County was created February 18, 1850 as one of the original 27 counties of California. The county is named for Cape Mendocino, the high headland discovered by Juan Rodriguez Cabrillo in 1542 [1] and named for Don Antonio de Mendoza, the first Viceroy of New Spain. Although Cape Mendocino is in Humboldt County, the name was given to the stretch of coast from the Cape south to Point Arena. Mendocino County remained sparsely populated and isolated except for transportation by boat for several years after it was created. The first redwood lumber mill on the Pacific Coast was established at Mendocino City in 1852 and the population increased from less than 100 to about 8,000 within 20 years.

By 1872 there were 19 saw mills in operation producing 50 million board feet of lumber per year, 19 grist mills and several breweries. Agricultural activities increased as a result of the lumber boom and soon grains, potatoes, hops and sheep were being raised. Lumbering remains the principal industry with more than 3,000 workers employed at peak periods.

Geography

Mendocino County is bounded on the north by Humboldt and Trinity Counties, on the east by portions of Tehama, Glenn, and Lake Counties, on the south by Sonoma County, and on the west by the Pacific Ocean. The county has a maximum length of 84 miles from north to south, a maximum width of 60 miles and embraces an area of 2,246,400 acres. Altitudes range from sea level to 6,963 feet. The Coast Ranges form two parallel ridges along the eastern boundary. The higher portions are precipitous and are dissected by gulches and ravines but the lower slopes are gentle and enclose many fertile valleys. The county is drained by two forks of the Eel River flowing northwest, the Russian River and its tributaries flowing southwest, and numerous smaller streams along the western coast. The western portion of the county is densely forested with redwoods, and the Mendocino National Forest, containing stands of white oak, pine and fir, is in the eastern part. The climate is cool and moist with January temperatures at Ukiah averaging 45 degrees and July temperatures averaging 72.2 degrees. Precipitation averages 35.27 inches per year.

[1] California Blue Book, California Dept. Finance, Sacramento, 1950.

Transportation

The main line of the Northwestern Pacific Railroad connecting San Francisco and Eureka runs northwestward along the Russian River through Hopland, Ukiah, and Calpella to Redwood Valley where it leaves the river and continues northwestward through Willits to Longvale. From Longvale the railroad parallels the Eel River through Dos Rios and thence to the Humboldt County line. A branch line called the California Western Railroad and Navigation Company runs westward from Willits down the Noyo River to Fort Bragg. The Redwood Highway (U. S. 101) runs northwestward through the center of the county and parallels the railroad to Longvale where it continues northwestward through Laytonville, Legget Valley, Piercy and Cummings to the Humboldt County line.

The Shoreline Highway (State Highway 1) runs northward along the coast; the McDonald to the Sea Highway (State Highway 28) runs northwestward from Cloverdale through Boonville and Navarro thence westward along the Navarro River to join State Highway 1 on the coast. Secondary roads connect the principal towns on the Shoreline Highway with Legget Valley, Laytonville, Willits, Ukiah and Hopland on the Redwood Highway, and other highways from Laytonville, Ukiah and Hopland connect with the Sacramento Valley to the east. There are 267 miles of state highway in the road system, 952 miles of maintained county roads, and 231 miles of primary county roads. The Greyhound Bus Lines has service along Highway 101 and the Southwest Airways stops at Ukiah and Fort Bragg. There is a small amount of waterborne traffic along the coast.

Industries

The 1950 population census of Mendocino County was 40,854, an increase of 45.7 percent over the 1940 count. The largest increase was in Ukiah, the county seat and largest city where the population increased 64 percent to 6,134. The growth was recently stimulated by the location of a large hardboard mill nearby. Ukiah is the trading center for the entire Ukiah Valley in the southwestern part of the county. The valley is covered with rich alluvial loam planted in part with Bartlett pears, hops, prunes, and grapes and sustains forage and pasture for cattle, sheep and hogs.

Willits, in the center of the county about 23 miles north of Ukiah in Little Lake Valley, serves a population of about 5,000. Its main sources of income are stock raising, dairying, and cultivation of pasture grasses. Covelo, in Round Valley northeast of Willits, is a cattle- and sheep-raising center as well as a scenic and recreational area. Fort Bragg, on the coast about 36 miles west of Willits, is the center of a lumbering, dairying and farming district and is the supply center for a recreational area featuring ocean and stream fishing, and hunting for deer and quail. A large lumber yard and redwood sawmill provide employment. Noyo, at the mouth of the Noyo River just south of Fort Bragg, is the center of commercial fishing in the area. A deepwater harbor protected by a breakwater is located here.

In the southern part of the county is the coastal town of Point Arena, which with the adjoining town of Manchester, is a trading center for a dairying, cattle- and sheep-raising region. Northeast of Point Arena is Boonville, in an apple-growing district, and southeast of Boonville is

Hopland, the center of the Sanel Valley and a rich hop-growing district. Potter Valley, northeast of Ukiah is the center of a fruit- and grape-growing area.

Lumber is the main industry of Mendocino County and 90 percent of the manufacturing employment is in lumber and lumber products. Lumbering has been active for a century and production has increased from 123,700,000 board feet in 1940 to 367,000,000 board feet in 1948 when 124 active mills were in operation.[2] The main item produced is redwood saw logs with additional production of fence posts, grape stakes, shingles, shakes, poles and pilings. In 1947 there were 93 plants manufacturing lumber and wood products, including five employing over 100 men each. One of the most important new industries in the county is a hardboard plant near Ukiah that uses mill wastes and small growth as a source of fibre.

Agriculture contributes 21 percent of the county's income. The climate is ideal for raising cattle and sheep, and the annual sales of livestock and livestock products, particularly sheep, lambs and wool, are high. Fruit and grapes are important crops with 7,400 acres planted to grapes and 2,146 planted to pears. Food processing and packing principally of wines and dairy products is one of the leading industries. Commercial fishing at Fort Bragg and Point Arena listed a catch valued at 6 million dollars in 1947. Other industries within the county include plants manufacturing chemicals, fabricated metal products and transportation equipment.

Recreation

Mendocino County is noted for its recreational facilities. Deer are abundant, particularly in the Mendocino National Forest as are quail, pheasant and grouse. There are hundreds of miles of trout streams, also steelhead and salmon fishing waters and miles of ocean shore for surf and abalone fishing and clamming. Chartered boats are available at Point Arena, Noyo and other harbors for deep sea fishing. The rivers and lakes are fine for swimming and boating and there are a variety of resorts, dude ranches, hunting and fishing camps, mineral spring resorts, recreational beaches, redwood groves and ideal camping sites for the tourist, vacationist and sportsman to enjoy.

GEOLOGY *

Mendocino County lies within the northern Coast Ranges geomorphic province (Jenkins, 1943, pp. 83-88). The topography is dominated by high ridges and narrow intervening valleys which trend northwest, parallel to the regional structure of the rocks. Huge landslides have in places produced highly irregular knobby topography on the flanks of the ridges. The San Andreas fault, one of the major structural features of California, crosses the southern boundary of the county about 2 miles east of Gualala and intersects the coast line a few miles north of Point Arena. This northwest-trending rift has strong topographic expression and is followed by the lower courses of the Garcia and Gualala rivers. The fault also separates Jurassic rocks on the east from Cretaceous and Tertiary rocks on the west.

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[2] California Blue Book, p. 901, 1950.

* Salem J. Rice, Assistant Mining Geologist, California Division of Mines assisted in the preparation of this section.

The county is largely underlain by rocks of the Franciscan formation of Upper Jurassic age. In places thick sections of Cretaceous and Tertiary sediments are preserved as downfaulted remnants, indicating that these younger rocks were formerly more widespread in the region but have been largely removed by erosion. Geologic maps are available for only two relatively small parts of the county, one of the vicinity of Covelo and the other of the area west of the San Andreas fault.

The Franciscan formation, which has been discussed at length by Taliaferro (1943), is composed predominantly of massive brownish- to greenish-gray sandstone with subordinate amounts of dark-colored carbonaceous shale. Interstratified in places with the sandstone and shale are lenses of thin-bedded red and green radiolarian chert. These masses of chert, usually less than a mile in length, are of economic significance because of the manganese deposits which are found in places in them. Pillow basalt and greenstone, representing contemporaneous submarine basalt flows, are commonly found associated with the chert. Minor amounts of conglomerate and limestone occur in places in the Franciscan interstratified with the other sediments.

In Mendocino County, as elsewhere in the Coast Ranges, the Franciscan formation has been intruded by sills and dikes of peridotite, now largely altered to serpentine. This is the rock in which the chromite deposits of the county occur. In places the Franciscan sediments and volcanic rocks have been altered to glaucophane schists, a colorful assemblage of metamorphic rocks. These commonly occur as small scattered outcrops in areas where serpentine is found.

The Gualala group of Cretaceous age, which crops out west of the San Andreas fault, has been mapped and described by Weaver (1943, 1944). This group comprises several thousand feet of alternating thick and thin members of brownish-gray medium- to coarse-grained quartzose sandstones, often gritty and pebbly, with lenses of conglomerate, and thick members of clay shale. Conglomerate beds are especially abundant near the base and middle of the series. Interstratified shaly sandstone and sandy shales constitute 30 percent of the entire stratigraphic sequence. These sediments have been folded into a series of northwest-trending anticlines and synclines which are truncated by the San Andreas fault, with Franciscan rocks to the east. At Bihler's Point the Gualala sediments rest on diabase of possible Franciscan age, and in the Point Arena area they are unconformably overlain by sediments of Miocene age.

Cretaceous sediments which crop out in the Covelo district to the southwest of Round Valley have been described by Clark (1940). In this vicinity the Cretaceous is composed primarily of approximately equal amounts of sandstone and shale. Lenses and beds of conglomerates make up only a small part of the series. These sediments are apparently part of a block about 7 miles long and 1 mile wide which has been faulted down into the Franciscan. They are disconformably overlain by sandstone of Eocene age which has been faulted down with them.

The bituminous Miocene sediments of Point Arena have been mapped and described by Weaver (1943, 1944), and more recently by Holmes, Page, and Duncan (1951). These sediments, which are best exposed along the sea cliffs near Arena Cove, are composed largely of diatomaceous siltstone which separates along bedding planes into layers 1 to 6 inches

thick. Most of the siltstones are chocolate brown on fresh surfaces but weather to light gray or greenish gray. Several beds of medium- to coarse-grained sandstone are present, and some of these are saturated with bitumen. Black siliceous shale beds and lenses are common, and are more abundant below the zone containing the bituminous sandstone. The Miocene sediments at Point Arena are closely similar in lithology to the Monterey formation in the San Francisco Bay area and probably are the same age.

The Temblor formation, of middle Miocene age, crops out in discontinuous areas to the west, southwest, and south of Round Valley (Clark, 1941), where it has apparently been faulted down into the Franciscan formation. It is composed primarily of sandstone and conglomerate, with some shale and a few beds of sub-bituminous coal.

Gravels and alluvium of Pleistocene and Recent age fill several broad, flat valleys in the county, such as Lake Valley and Round Valley.

MINERAL RESOURCES

The value of mineral production of Mendocino County from 1880 to 1950 totals $4,391,105, as shown in table 1. The production of sand and gravel for aggregate has been the principal mining industry in recent years. It is followed by the production of natural carbon-dioxide gas which is used in the manufacture of dry ice. During World War I Mendocino County was an important producer of high-grade lump manganese ore but little has been mined since then and no new deposits have been developed. Mineral water was bottled and sold from 1899 to 1909 and the 442,770 gallons produced in that period were valued at $114,554. No mineral water has been sold since 1909 but resorts have been built at several of the mineral springs. The chromite deposits found in the irregular outcrops of serpentine in the Franciscan formations have been small and their development has been handicapped by the lack of roads and the distance to market. A production of 914 tons is recorded from 1918 to 1942. Deposits of a good grade of sub-bituminous coal occur in beds 12 to 14 feet thick in the Eel River district east of Dos Rios but their development has been discouraged by the competition of petroleum, natural gas and hydroelectric power. Coal production was reported for three years from 1923 to 1925 when the Camp Carbon mine was being developed and in 1948 when 40 tons were shipped from the Flood mine. Other minerals for which a small production has been recorded include bituminous rock, brick, clay, gold, limestone, magnesite, natural gas, platinum, quicksilver and silver.

Carbon Dioxide

Carbon dioxide gas seeps are reported from ten locations in Mendocino County (Hubbard, 1943) and commercial production has been obtained from wells drilled near Hopland and at Ukiah.

The *Cal Dri Ice Corporation* of San Francisco has been manufacturing dry ice since 1939 from carbon dioxide gas wells drilled on the east bank of the Russian River about 2 miles north of Hopland. The land is described as being Lot 36, East Sanel Rancho and is owned by A. F. Moulton and associates. Seven wells have been drilled and range from 350 to 790 feet in depth. Carbon dioxide gas and hot water flow through

FIGURE 1. Cal Dri Ice Corporation plant near Hopland.

the well casings into a metal cylindrical tank in which the gas is separated from the water. The dry gas is cooled and stored in three tanks, 3 feet in diameter and 60 feet long from which it is drawn and compressed in two stages to 550 pounds per square inch pressure. The gas is cooled to a liquid in ammonia condensers and the entrained water is removed by passing the gas through four steel cylinders filled with calcium chloride crystals. The liquid carbon dioxide is run through cylinders filled with carbon and other reagents to remove impurities and stored in a tank under 550 pounds pressure. The liquid changes to "snow" when it is released into a chamber in which the pressure drops to 135 pounds per square inch and the snow is pressed into cakes in a hydraulic press under 2,000 pounds pressure.

The plant has a capacity of about three hundred and sixty 10- by 10- by 12-inch cakes in 24 hours. The dry-ice cakes are double-wrapped with paper and stored in an insulated room or loaded directly into refrigerator trucks for delivery to consumers. A new hydraulic press having a capacity of 20 tons of cakes under 2,500 pounds pressure was being installed in July 1952. The company operates six refrigerator trucks of 190 to 250 block capacity and deliveries are made to Sacramento, Stockton, Redding and San Jose. Five men are employed and the plant is operated on three 8-hour shifts. Henry De Lotty, general manager, has an office in Ukiah.

The *Gibson carbon-dioxide wells* were drilled in Ukiah on the south side of Clay Street just west of Eastlick Street on land owned by L. J. and Bess Gibson. Number 1 well was drilled to a depth of 235 feet and has 75 feet of 10-inch diameter casing. The gas was shut in. Number 2 well was drilled 465 feet deep and has 250 feet of 12-inch diameter casing. The carbon-dioxide gas and water flowed freely from the second well for a while but later had to be pumped. A processing plant at the

TABLE 1. MINERAL PRODUCTION OF MENDOCINO COUNTY, 1880-1950

Year	Brick		Manganese ore		Mineral water		Miscellaneous stone[1]	Miscellaneous and unapportioned		
	M	Value	Tons	Value	Gallons	Value	Value	Amount	Value in dollars	Substance
1880									$733	Gold
									125	Silver
1881									1,000	Gold
1882										
1895								50 tons	150	Coal
1896										
1898	258	$1,080						450 tons	2,250	Bituminous rock
1899	200	1,800			17,470	$6,988				
1900	25	400			24,875	8,048				
1901	200	2,500			27,950	8,220				
1902	200	2,000			28,575	7,898				
1903	550	5,580			38,900	15,000				
1904	260	3,120			40,000	12,000			75	Gold
1905	635	6,470			90,000	18,000			40	Gold
1906	500	5,000			40,000	9,800			19	Gold
								50 flasks	1,825	Quicksilver (1906)
1907	400	4,000			45,000	9,800				
1908	260	2,600			45,000	9,800				
1909	150	1,500			45,000	9,000	$1,200		18,000	Unapportioned, 1900-1909
1910							500			
1911	160	1,600								
1912							300			
1913							9,450			
1914							560			
1915			2,858	$23,036			1,500			
1916			1,735	43,005			8,275	300 tons	2,400	Magnesite
									2,000	Other minerals
1917	[2]		1,541	40,515			5,600		4,300	Brick, chromite, magnesite
1918			1,432	58,962			5,000	555 tons	226	Gold, platinum
									44,200	Chromite
1919							7,000		7,214	Chromite, platinum
1920							7,500		18,610	Chromite, manganese, natural gas, platinum
1921	[2]		[2]						1,509	Gold
							40,000		13	Silver
									3,200	Brick, manganese, natural gas, platinum

1922	[2]						18,762		1,800	Brick, natural gas, platinum
1923							48,360		5,050	Coal, natural gas
1924	550	7,125					49,680		3,963	Coal, natural gas, platinum, manganese
1925	[2]						11,603		4,930	Brick, coal, natural gas
1926							15,750		50	Other minerals
1927	[2]						44,630		3,040	Brick and natural gas
1928							40,420		20	Other minerals
1929	[2]						55,925		3,075	Brick, natural gas
1930	[2]						119'429		3,633	Brick, limestone, natural gas
1931							70,755		1,952	Other minerals
1932							101,619		50	Other minerals
1933							35,010		155	Gold
									118	Limestone, natural gas
1934							14,301		50	Other minerals
1935							10,389		40	Other minerals
1936							35,521		75	Other minerals
1937							[2]		35,596	Natural gas and miscellaneous stone
1938							[2]		114,705	Natural gas and miscellaneous stone
1939							[2]		46,378	Carbon dioxide, natural gas, miscellaneous stone
1940							107,507		70	Gold
									1,533	Carbon dioxide and natural gas
1941							43,809		30,184	Carbon dioxide, coal, natural gas, platinum
1942			[2]				57,368		76,627	Carbon dioxide, chromite, manganese
1943			[2]				43,174		39,306	Carbon dioxide, chromite, manganese, natural gas
1944			[2]				68,701		83,338	Carbon dioxide, manganese and natural gas
1945							58,732		60,035	Carbon dioxide and natural gas
1946							306,973		76,458	Other minerals
1947									M528,181	Sand and gravel
1948									M491,130	Carbon dioxide, sand and gravel
1949									M502,027	Carbon dioxide, sand and gravel, stone
1950									399,497	Carbon dioxide, sand and gravel, stone
Totals	4,348	$44,775	7,566	$165,518	442,770	$114,554	$1,445,303		$2,620,955	
Grand total									$4,391,105	

[1] Includes crushed rock, rubble, rip-rap, sand, gravel.
[2] See under "Unapportioned."
San Francisco County included.
Grand total, $4,391,105.

site of the wells removed the entrained water, filtered out the impurities, compressed and cooled the gas to a liquid. Deliveries were made in insulated tank trucks. The plant has been idle since 1948.

Chromite

In Mendocino County deposits of chromite occur in the Coast Ranges in lenses or pods in the sill-like sheets of serpentine which intrude the upper part of the Franciscan group and the lower part of the Knoxville formation. Two main groups of deposits are known (Dow and Thayer, 1946, pp. 17-19), one southeast of Ukiah, in the southeastern part of the county, and the other west of Cummings, in the northwestern part. The deposits mined have been relatively small, and their development was handicapped by lack of access roads and the long distance to markets. There are many deposits listed in the accompanying table of mines but only the Guthrie group described below is credited with a production exceeding 50 tons. Descriptions of chromite deposits which were idle at the time the field work for this report was done are taken from the earlier reports listed in the table of mines.

The *Graham group* is along the high part of the ridge on Big Red Mountain near the center of T. 14 N., R. 11 W., M. D., and is reached by 4 miles of a very steep dirt road to Lost Valley from the county gravelled road, and 2 miles of trail from Lost Valley. Three of the claims were leased by the Noble Electric Steel Company in 1918 and a few tons of high-grade ore and about 75 tons of low-grade ore were mined. The deposits consist principally of thin seams and small lenses of massive and disseminated chromite in dunite. Many of the seams of ore average 30 to 50 percent Cr_2O_3 but they are so thin and intermixed with barren dunite that the mineable rock would exceed 20 percent Cr_2O_3 in very few places. The largest of the high-grade ore bodies yielded about 5 tons of ore. High-grade float is abundant but the individual pieces are small. The principal body of low-grade ore is near the north end of the high part of the Big Red Mountain, just east of the divide. The streaks and lenses of chromite strike north and are nearly vertical. They were exposed by pits and cuts for a length of 50 feet. The chromite-bearing zone was described as being at least 25 feet wide, and in places up to 50 feet wide although exposures were not continuous across the entire width. A vertical depth of 50 feet was indicated by exposures in a gulch below some open pits. The deposit was estimated to include 10,000 to 30,000 tons of ore containing 10 percent Cr_2O_3 (Davis and Woodford; Dow and Thayer, 1946, pp. 17-18).

About 35 tons of ore averaging 40 percent Cr_2O_3 were dug from several trenches on the old *Summit claim* near the top of the mountain. Near the south end of this claim, and about 200 feet below the crest of the mountain, an adit was driven about 30 feet along the strike of an ore body in which the layers strike N. 20° E. and dip 35° E. Wells stated that this ore body is about 15 feet thick, and estimated the reserves at about 500 tons of 5 to 10 percent Cr_2O_3 grade. In 1941 most of the workings were caved and very little ore could be seen. No production has been reported in recent years.

The *Guthrie group* is on Big Red Mountain northwest of Cummings in secs. 18, 19, 20, 29, 30, 31, and 32, T. 24 N., R. 16 W., M. D. In 1918 more

than 100 claims were filed and they extended more than a mile along the crest of the ridge at altitudes of 4,500 to 4,700 feet. The deposits are 37 miles from the railroad at Longvale. Most of the chromite occurs as float leached out of serpentine. A total of 914 tons of ore was shipped to 1929. The ore came from 10 or more lenses which ranged from N. 35° W. to N. 15° E. in strike, and dipped 50° to 65° NE. to E. The largest deposit is believed to have yielded about 100 tons. Some streaks and nodules of chromite still show in the serpentine on the Marie, Mitty, Last Chance and Surprise claims but no shipments have been made in recent years.

The *Little Red Mountain (Dunn) deposit* is located in sec. 5, T. 23 N., R. 16 W., M. D., about 3 miles east of U. S. Highway 101. In 1941, Wells stated that a lens of coarse-grained massive chromite about 2 feet wide was exposed in a trench near the northwest corner of sec. 6. It is said to have assayed 52 percent Cr_2O_3 and about half a ton of ore was on the dump. High-grade disseminated ore in which some nodules were noted was exposed in another trench. The property has not been worked in recent years.

Clay

Common brick clays are available near the coast at the town of Mendocino, and also at Ukiah. Brickyards were at one time operated in these places, and at Talmadge (Talmage), near Ukiah. The Mendocino State hospital at Talmadge is built of brick manufactured from clay taken from a local deposit of gravelly silt about 10 feet deep and extending over about half an acre (Dietrich, 1928, pp. 126-127). The material was mined with a plow and scraper and the bricks were fired in open field kilns. There has been no production since 1924.

Coal

Deposits of sub-bituminous coal in the Eel River district of Mendocino County were reported by Peckham as early as 1872 (pp. 41-48) but their remoteness from markets and the competition of petroleum, natural gas and hydroelectric power have discouraged their development. A gently dipping bed of coal about 14 feet thick crosses the Middle Fork of the Eel River at the mouth of Salt Creek in sec. 11, T. 21 N., R. 13 W., M. D., about 5 miles east of Dos Rios. According to Laizure (1923), the coal was traced south of the river soon after its discovery and an outcrop was noted near the center of the section line common to secs. 13 and 24, T. 21 N., R. 13 W., M. D. In this locality the coal occurs in isolated patches of the middle Miocene Temblor formation which are down-faulted into the underlying Franciscan sandstone (Clark 1941). The thickest coal outcrop, on the north bank of the Eel River, is in an area of recent active landsliding. About 400 feet east of an adit of the Ocean coal mine, the Temblor beds, including the coal near their base, are faulted against Franciscan (?) intrusive diabase. A few prospect holes were dug in sec. 24 and about 1903 an adit was run southwestward for a distance of 70 feet. This adit was almost entirely in coal. Nothing further was done until February 1923 when the Camp Carbon Company took over the property under a contract to purchase.

The *Camp Carbon (Thomas) coal mine* includes land located in the SE$\frac{1}{4}$ sec. 13; E$\frac{1}{2}$ sec. 24; N$\frac{1}{2}$ SW$\frac{1}{4}$; NW$\frac{1}{4}$ and E$\frac{1}{2}$ sec. 25, T. 21 N., R. 13 W., M. D. owned by the Thomas estate of Ukiah. From February 1923 to

August 1926 the property was actively developed by the Camp Carbon company and a production of coal is recorded for those years. An inclined shaft was sunk 450 feet on the vein which dips east about 15 degrees and about 500 feet of drifts were driven on the vein. The workings have filled with water since the mine was closed but Averill (1929, pp. 460-461) quotes Mr. A. L. Fisher who was in charge of the work, as stating that with the exception of a pinch near the surface, all the work was in a bed of coal which was 12 feet thick. The coal is a uniform black color and the more solid portions break with a conchoidal fracture. An analysis of a sample taken from the entry soon after it was started is quoted from Laizure (1923, p. 153):

Volatile combined matter	54.2 percent
Fixed carbon	43.8 percent
Ash	2.0 percent

Except for some prospecting of surface outcrops with a bulldozer in 1946, the property has been idle in late years.

FIGURE 2. Outcrop of subbituminous coal on the Flood estate east of Dos Rios.

Ocean coal (Eel River, Flood) mine is located in sec. 2, T. 21 N., R. 13 W., M. D., and is included in a tract of 23,234.48 acres to which the Flood Estate owns the mineral rights. The mine is reached by a road which turns south from the Dos Rios-Covelo highway about 6½ miles east of Dos Rios. The coal was developed by an adit driven 50 feet in a bed of firm, shiny black coal which was 12 to 14 feet thick. The strike varied from N. 60° W. at the portal to N. 75° W. at the face and the dip varied from N. 34° E. to 80° SW. Both walls are firm, fine-grained shale. In December 1947 the property was under lease to E. J. Thorpe of Stockton and associates. A road was built to the property and a portion of the coal bed near the portal was stripped of the red soil, sandstone and shale overburden. About 40 tons of coal were mined and shipped from Dos Rios in

the early spring but in June 1948 the property was idle and all equipment had been removed. There has been no further development.

Copper

Outcrops of copper-stained rocks have been prospected in many places in Mendocino County but no deposit has yet been developed into a profitable operation. No recent work has been done on these prospects and the descriptions of the following properties were taken from earlier reports, references to which are cited in the accompanying table of mines.

The *Deep Hole (Eden Valley) mine* is located in sec. 13, T. 20 N., R. 12 W., M. D. about 20 miles northeast of Willits. Three or four veins from 4 inches to a foot in width strike northwest and dip 22° NE. The veins are composed of quartz carrying chalcopyrite and malachite and average about 10 percent copper. The hanging wall is soft slate and the footwall is quartzite. The vein has been traced for 200 feet on the surface and for a depth of 40 feet in a shaft.

The *McGimpsay prospect* is located in sec. 23, T. 13 N., R. 12 W., M. D. Four shallow open cuts have exposed serpentine stained with copper carbonate and some oxides of copper and iron.

The *Red Mountain (Red Buck, Salinas) prospect* included four claims located in sec. 23, T. 15 N., R. 12 W., M. D. Some metallic copper and green copper carbonate occur in small bunches in a serpentine outcrop. They have been prospected by two shafts, one 100 feet deep and another 50 feet deep, and by shallow trenches and short adits. Aubury (1902, p. 135) reported that one ton of ore mined above the 50-foot level in one shaft and shipped to San Francisco in 1896 netted $12.00 above cost of mining, shipping and treatment. The shaft was sunk to a depth of 100 feet without finding more ore and was bottomed in broken sandstone and clay. The property has been idle since 1896.

The *Redwood Copper Queen prospect* includes 840 acres of patented land in secs. 17, 20, T. 12 N., R. 13 W., M. D., owned by the Redwood Copper Queen Company, 217 Hillside Ave., Piedmont, California. Exploratory work has disclosed a mineralized zone 300 feet long, 10 to 40 feet wide, and 125 feet deep in highly altered sandstone which is covered with a thick layer of soil. The ore occurs as kidneys and lenses of heavy iron sulphide carrying 8 to 9 percent copper and a small amount of gold and silver. The largest kidney mined was 75 feet long and 6 feet thick. In 1906, 400 tons of ore were shipped to the Pyeton Chemical plant for treatment (Lowell, 1914). Its high sulphur content and the absence of arsenic made it desirable for the manufacture of sulphuric acid.

Gold

Narrow veins and stringers of quartz occur in the metamorphosed rocks of the Coast Ranges and sometimes contain small amounts of gold and copper. Early reports of the California Division of Mines mention two prospects which were abandoned after a small amount of work failed to disclose profitable ore.

The *Boy Edgar prospect* is on the trail to Lost Valley, about 12 miles southeast of Ukiah. Five small quartz veins are reported to have been cut by an adit driven 25 feet through slate (Crawford, 1894, pp. 176-

177). The largest vein was 15 to 20 inches wide with a northeast strike and a vertical dip. The quartz assayed $4.75 in gold. The property was owned by C. H. Stout of Ukiah in 1896 but the mine has long since been abandoned.

The *Van Allen mine* is 6 miles west of Ukiah. Five prospect adits, one 170 feet long driven through a hard, tough, blue glaucophane schist cut several stringers of quartz striking N. 64° W. and dipping 45° N. The property was owned by William Van Allen of Ukiah in 1914 but there has been no production or assessment work recorded in recent years and it has probably been abandoned (Lowell, 1914, p. 420).

Graphite

The occurrence of graphite in Mendocino County is noted in early publications of the California State Mining Bureau. There has been no activity at these properties for over forty years so the following descriptions are taken from these earlier publications.

John L. McNab Property. "There is reported to be a bedded deposit of graphite on property belonging to John L. McNab et al., in T. 13 N., R. 12 W., M. D. The nearest town is Hopland. The mineral was discovered by the ranch superintendent in 1903. An Oakland firm is said to have offered $160 per ton for the material at the time, but owing to litigation, etc., nothing was ever done with it." (Castello 1920, p. 145)

The *Western Graphite Company* owned and operated a graphite deposit about 15 miles east of Point Arena in sec. 8, T. 12 N., R. 15 W., M. D. The graphite occurs in a blanket formation and it was mined by quarrying. The material was puddled and washed to free it from quartz inclusions and shipped to San Francisco for refining. The graphite was used in paint, lubricants and for foundry facings. (Aubury, 1906, p. 280)

Jade

Jade is a name given to the massive varieties of the two rock-forming minerals nephrite and jadeite. Nephrite is an amphibole, a calcium magnesium silicate that usually contains a small amount of iron, while jadeite is a pyroxene, a sodium aluminum silicate that usually contains variable amounts of calcium, magnesium, and iron. Jade ranges in color from pure white through all shades of green to amethyst, mauve, violet and light blue, yellow, orange, and tints of brown, red and black. However, shades of green are most common. The amount of jade of gem quality which has been found is rather small.

The nephrite variety of jade occurs as veinlets and irregular pods within and on the margins of serpentine sills that intrude Franciscan graywacke in the Leech Lake Mountain district of Mendocino County. Specimens of pale to dark green nephrite as much as 12 inches in length have been found among stream boulders in Williams Creek and in a few shallow pits in that district. Several claims, both lode and placer locations were recorded for jade in 1951.

Charles Stockton of Covelo and G. H. Weise of Martinez located four quartz and four placer claims for jade in the Leech Lake Mountain district in 1951. Several hundred pounds of sorted material containing pale to dark green nephrite were packed out to Covelo and selected

specimens were cut and polished. Some have been mounted into rings, bracelets, brooches and other ornaments and sold.

The occurrence of jade in this locality created considerable interest and many people visited the district in the summer of 1951. The only other mining locations recorded, however, were those of W. L. Taylor and associates who located the Aztec Associated placer of 160 acres and the Burma Queen and Rangoon quartz claims. The claims are undeveloped except for discovery work and shallow cuts and trenches. They were idle in October 1952. Development of these properties are handicapped by the lack of access roads. Everything must be packed in and out by pack trains over about 11 miles of trails.

Limestone

The Franciscan rocks which cover most of Mendocino County contain numerous small bodies and veins or stringers of calcite, limestone, and calcareous tufa but the only recorded production of limestone was from a deposit near Laughlin between 1930 and 1933 (Logan, 1947, pp. 253-254).

The *Fisher Ranch deposit* is in the E½ and NW¼ sec. 36, T. 22 N., R. 15 W., M. D. and is owned by Marshall and Pauline C. Fisher of Laytonville. Limestone crops out in two small hills about 150 feet apart. The outcrop on the north hill is about 345 feet long and 105 feet wide and that on the south hill is 85 by 165 feet. The limestone is hard and fine-grained and varies in color from pink to yellowish gray. An analysis by Abbot A. Hanks, Inc., San Francisco is quoted from the Logan report cited above.

	Percent
Insoluble	5.56
Ferric and aluminic oxides	0.69
Calcium carbonate	93.16
Magnesium carbonate	0.39

There has been no production recorded from this deposit.

The *Quinan Ranch deposit* is in sec. 26, T. 17 N., R. 13 W., M. D. A terrace deposit of travertine and calcareous tufa crops out over an area 250 by 100 feet near the top of a ridge. A lower terrace where the limestone was mined covers about an acre and a pit 27 by 50 feet and 10 to 15 feet deep exposes a bed of travertine 6 to 8 feet thick. This deposit was mined by the Northwest Pacific Lime and Sulphur Company between 1930 and 1933. The material was crushed and pulverized in a plant at Laughlin and used for agricultural purposes. An analysis of the limestone made by Abbot A. Hanks, Inc., of San Francisco is quoted from Logan's report (1947, p. 254).

	Percent
Insoluble	3.20
Ferric and aluminia oxide	0.24
Calcium carbonate	94.97
Magnesium carbonate	1.51

Magnesite

A small production of magnesite was recorded from two properties in Mendocino County in 1916 and 1917. The deposits were small and irregular and they have probably been exhausted.

The *Hixon Ranch (Vassar Ranch) deposit* is in sec. 11, T. 12 N., R. 11 W., M. D. on land owned by Ancel E. and Zella Irene Fox. Small and irregular outcrops of magnesite occur in the decomposed serpentine along the slope of the hill about 1,000 feet east of the Russian River. A deposit about 250 feet above the river was mined to a depth of 8 feet. Bradley (1925, p. 52) reported that about 50 tons of white magnesite had been mined and was ready to ship when he visited the property and that other deposits higher up the ridge had been worked out, some by Woods in 1917 and others by Arthur McCray of Cloverdale.

The *Southard Ranch deposit* was reported by Bradley (1925, p. 52) as being 2 miles from the railroad at Willits. A ledge of magnesite 4 feet wide and 50 feet long was mined from an open cut. The vein was vertical between walls of hard serpentine and pinched down to a 10 inch width at a depth of 30 feet. It was mined by J. C. Duffield and Chas. Whited of Willits in 1916 who shipped 150 tons of high-grade magnesite. There are no other known outcrops of magnesite in the vicinity.

Manganese

More than 80 percent of the recorded production of manganese in California was mined during the World War years. In those years, government programs were set up to enable small operators to mine small deposits and to make deliveries of small lots of ore to conveniently located government operated ore-purchasing depots. When these depots were closed down at the end of World War II the domestic deposits could no longer compete with imported ore and they were forced to shut down. The General Service Administration has recently inaugurated a program to stimulate the production of domestic manganese and it is probable that some of the now idle California deposits will be reopened.

Mendocino County has been one of the largest producers of manganese ore in California. Publications of the California Division of Mines (Bradley, 1918, p. 248; Jenkins, 1943; Trask, 1950) list 61 deposits in the county, three of which have a recorded production of over 1,000 tons each, four produced from 150 to 999 tons, ten from 1 to 149 tons, and 44 with no recorded production. The deposits all occur in the Franciscan formation as lenses of oxides interbedded with radiolarian chert. They are usually associated with the more massive cherts that interrupt the bedding of the thin-bedded chert and shale. The known deposits are all in the eastern half of the county except a group near Usal in the northwestern corner. The primary minerals are rhodochrosite or a mixture of rhodochrosite with bementite, rhodonite, or manganiferous chert. They are oxidized to the black manganese oxides at the surface and along joints and fractures.

About half of the manganese ore produced in the county came from the Thomas mine about 15 miles north of Ukiah. Most of the remainder came from the South Thomas, the Wild Devil, Bevins-Busch, Nowlin, Brereton, and Foster Mountain mines. These mines were all idle when the field work was done for this report and the descriptions of the following properties are taken from earlier reports.

The *Bevins-Busch (Lee, Potter Valley) deposit* is about 5 miles northwest of Potter Valley Post Office in secs. 3, 10, T. 17 N., R. 12 W., M. D. Massive psilomelane $1\frac{1}{2}$ to $2\frac{1}{2}$ feet thick was exposed in six lenses on this

property. The footwall of the ore body is well-bedded red radiolarian chert and the hanging wall is massive chert that has been somewhat brecciated. About 200 tons of ore were mined at this property but it is now idle and the claims have probably been abandoned.

The *Brereton (New Year, Old Country) mine* is northeast of Covelo on the north side of the ridge in sec. 31, T. 23 N., R. 11 W., M. D. The ore is a high grade gray manganese carbonate which is covered by a film of black manganese oxide and cut by numerous veinlets of pink rhodochrosite. It occurs in faulted bodies of red, green and gray chert striking northeast and dipping northwest. About 150 tons of ore were mined here from open cuts and stopes during World War I. The old cuts and adits are now caved and there has been no activity at this deposit in recent years.

The *Foster Mountain (Busch, Independent, Lucky Boy) mine* is near the summit of Foster Mountain about 16 miles east of Willits in secs. 3, 10, T. 18 N., R. 12 W., M. D. The deposit occurs in a belt of brown and buff chert striking northwest and dipping southwest, generally at a high angle. The chert is contorted and very much broken by numerous faults. Most of the ore was mined from two large open cuts and from a drift and stope at the northwest end of the ore zone. The ore was mostly high grade psilomelane and varied from 2 to 5 feet in thickness. Mr. George Busch, one of the operators, stated (Trask, 1950, p. 130) that 4,500 tons of ore averaging more than 45 percent manganese and less than 7 percent silica were shipped from this deposit from 1916 to 1918. In 1925 about 1,000 tons of ore were mined from a drift and stope along the continuation of the ore body exposed in the upper cut. In 1944 the entire area of the old workings was uncovered by a deep bulldozer cut and the ore which had been left in pillars and caved areas was recovered. About 300 tons of ore averaging 47.5 percent manganese and 23.8 percent silica were recovered. There has been no production recorded since 1944.

The *South Thomas mine* is on the southeast slope of Round Mountain in the northeast corner of sec. 27, T. 17 N., R. 12 W., M. D. There are two parallel beds of manganese ore, separated by about 15 feet of well-bedded red chert. The lower bed to the west was developed by shallow cuts and two short adits. The ore thickness varies from 1 foot to 2 feet and the ore is not of uniform value. Lenses and pods of rather high-grade oxide ore are found, but much of the ore contains large amounts of white chert. The bed is highly sheared, and there are many fractures filled with a black gouge which parallels the manganese bed and the enclosing red chert. The gouge strikes N. 10° W. and dips 60° E. in the lower adit for most of its length but at the face it flattens out over the top of the ore cutting it off.

The higher bed to the east is developed by an open cut 150 feet long which is now caved. The footwall shows red chert with thin shale partings. About 1,500 tons of black oxide ore were shipped from this mine. Most of it was probably mined from the upper ore bed, which is not now exposed. The mine has been idle since the end of World War I and the road from Redwood Valley is now impassable.

The *Thomas (Round Mountain) mine* is on the east side of the ridge between Potter Valley and Redwood Valley in the N½ sec. 22, T. 17 N., R. 12 W., M. D. The main ore body had a length of 650 feet and a general strike of N. 45° W. with a dip ranging from 65° NE. to nearly vertical. It was cut by several small transverse faults. Most of the ore was mined from an open cut 350 feet long on the east slope of Hill 1750; another cut 50 feet north was 80 feet long; a cut south of the canyon on the north slope of Hill 1810 was 100 feet long; and cuts on Ridge 1850 extend for 120 feet.

Three adits were driven northwest along the ore body on Hill 1750 at elevations of 1,530, 1,560 and 1,570 feet. These are now caved or partly caved. Farther north two adits were driven southwest into the hill and another adit near the bottom of the canyon 170 feet east of the ore bed probably did not reach the chert bed. These adits are also caved.

South of the canyon on the north slope of Hill 1810, an adit was driven south along the ore body at an altitude of 1,550 feet; two others were driven southwest at altitudes of 1,590 and 1,620 feet. These adits are also caved and it is doubtful that they struck the ore body.

The Thomas mine is credited with a production of 6,230 tons of ore from 1914 to 1918, averaging 50 percent manganese and 7 to 10 percent silica. Of this amount 1,500 tons may have come from the South Thomas mine. While it is probable that most of the black oxide ore has been mined, there are favorable areas remaining to be explored and there should be good chances for developing large reserves of primary ores which are probably neotocite and rhodochrosite (Trask, 1950, p. 145). There has been no production from the Thomas mine since 1918 and the road to the property is now impassable.

The United States Bureau of Mines made beneficiation studies on a mixture of the high- and low-grade ores taken from surface outcrops at the Thomas mine and the results published in 1952 (Potter, Sandell, and Vincent, 1952). The conclusions were "1. The relatively large amount of manganese occurring as rhodonite (manganese silicate) in the Thomas ore, together with the extremely intimate quartz-manganese association, limited recoveries of low-silica manganese products that could be produced by ore-dressing methods. 2. By a complex flotation method involving fine grinding, 21 percent of the manganese was recovered in a product that, when sintered, assayed 49.9 percent manganese. Lower-grade products with high silica content representing a recovery of 55 percent of the manganese in the ore were obtained by inclusion of lower-grade middlings."

Mineral Paint

Deposits of yellow and red ochre have been found in Mendocino County but have not been exploited. Watts (1892, pp. 255-256) reported that many settlers made paint with a ferruginous rock taken from a large deposit at Red Mountain about 6 miles south of the Humboldt County line.

Mineral Springs

There are many mineral springs in Mendocino County and several having scenic surroundings have been developed into resorts and are equipped with cabins and hotel accommodations for guests. Most of the

spring water is cold and carbonated but there are a few warm and sulphur springs. A production of 442,770 gallons of mineral water valued at $114,554 is recorded from 1899 to 1909.

The *California Seltzer Springs* are in the mountains in southern Mendocino County about 12 miles north of Cloverdale. The water is carbonated and sparkling and has a temperature of 57 degrees. A hotel was operated at this spring at one time but it has been closed down in recent years.

The *Duncan Mineral Springs* are about a mile and a half southwest of Hopland in the SE¼ sec. 25, T. 13, N., R. 12 W., M. D. There are five cold springs on this property, two of which are soda, and one a sulphur spring. The other two are called ''Borax'' and ''Duncan'' springs, the latter being the principal spring. The chief minerals contained in the water are magnesia, lime, soda, and potash with about 36 percent free carbonic acid (Lowell, 1914, p. 424). A resort is operated at the springs with hotel accommodations and a swimming pool for the guests.

Orr's Springs are in a narrow canyon on the South Fork of Big River about 14 miles northwest of Ukiah in sec. 24, T. 16 N., R. 12 W., M. D. Five warm springs having sulphur, iron and magnesia in solution have been developed and piped to baths and a swimming pool. Cabins, tent houses, and hotel accommodations have been built and the place is operated as a resort from June to September.

The *Vichy Springs* are in Doolan Canyon, about 3 miles northeast of Ukiah in sec. 11, T. 15 N., R. 12 W., M. D. There are three springs issuing from beneath a bed of calcareous tufa 15 to 20 feet thick. The water of the Upper (Crystal) spring has a temperature of 45 degrees and is not used for bathing. The Vichy spring flows about 20 inches of water at a temperature of 93 degrees Fahrenheit and the Ardeche spring about 8 inches of water. Both are used in the baths and swimming pool. An analysis of the waters (Lowell, 1914, p. 423) shows that they contain soda, lime, magnesium and iron carbonates, sodium and potassium chlorides and silica, very similar in amounts contained in some of the famous European waters. The springs are owned by Arnold and Henry Erickson and they have been developed into a resort with hotel accommodations.

Natural Gas

In 1887 Weber (pp. 181-191) reported that Hiram Willits, of Willits, bored a well 75 feet deep for water at Casper Creek but struck a small flow of gas instead.

In 1920 Boalich (pp. 147-148) reported that Austin Muir had been using natural gas for 5 years from a well 200 feet deep on his place 3 miles east of Willits. A small production of natural gas has been recorded for Mendocino County each year with few exceptions since 1920.

Nickel

Averill (1929, p. 646) reported that a small amount of nickel was said to occur in the sulphides found in the red and brown chert taken from a prospect tunnel 15 to 20 feet long on the Bell Valley mine on leased land in sec. 4, T. 13 N., R. 13 W., M. D. The amount of nickel was so small that it was not thought to be worth developing.

Petroleum

Evidence of the occurrence of petroleum is in the Point Arena beds (Monterey formation) of Miocene age which are exposed in the sea cliffs about a mile west of the town of Point Arena. The Point Arena beds have been described by Weaver (1943, pp. 628-632) as "An assemblage of alternating units of interstratified grayish-brown clay shales, diatomaceous shales, foraminiferal shales, cherty shales strongly contorted, and units of thinly laminated sandstones and cherty shales and clay shales. At occasional intervals there occur layers of sandstone nearly 50 feet thick. Two of these are saturated with petroleum residues." Although seven wells have been drilled, one to a depth of 7,632 feet, no petroleum production has been made to date.

The search for petroleum started in 1864 when the *Point Arena Petroleum Oil and Coal Mining Company* was organized and several wells were sunk in the area. They failed to find any oil but beds of bituminous sandstone up to 20 feet thick were developed at various places (Weber, 1887, pp. 200-202). A plant was built to distill oil from the bituminous sandstone and a good grade of oil was produced but the cost of production and marketing was too high for the operation to be profitable.

The *Mendocino Coast Oil Company* drilled the *Robbins well* at the northwest corner of sec. 11, T. 12 N., R. 17 W., M. D. to a depth of 2,240 feet in 1905. It bottomed in Monterey shale (Oakeshott, 1952, p. 26). A Fresno company drilled the John D. well on the Hunter Ranch near the center of sec. 11, T. 12 N., R. 17 W., M. D. to a depth of 1,700 feet in 1910 and in 1918, *Brandenstein and Silverberg* drilled a well in the northwest quarter of the same section. This well was located on the axis of the O'Neal anticline and was drilled to a depth of 780 feet. Tar sands were logged from 522 to 715 feet and the hole was bottomed in Miocene. (Oakeshott, 1952.)

The *Twin States Oil Company* drilled *"Soldani 1" well* to a reported depth of 7,632 feet in 1931. It was located about a quarter of a mile south of the Port of Point Arena in sec. 14, T. 12 N., R. 17 W., M. D. Core samples obtained from depths of 4,450 feet and 4,707 feet are considered to be of Miocene age and representative of strata in the Coast Ranges known to occur directly above Vaqueros. The hole was bottomed in hard rock, probably Cretaceous (Oakeshott, 1952).

The *N. F. Keyt well* drilled in 1940-1941 in sec. 3, T. 12 N., R. 17 W., M. D. to a depth of 1738 feet is thought to have bottomed in Miocene beds (Oakeshott, 1952).

Oil and gas leases were taken on land in secs. 29, 30, 32, T. 13 N., R. 16 W., M. D. in 1951 but drilling had not started at the time field work for this report was being done.

Holmes, Page, and Duncan (1951), in a recent study of the Point Arena area, made careful estimates of the reserves of bituminous sandstone. They based their computations on the assumption that the sandstone could be mined to a depth of as much as 200 feet below the surface of the ground, but not below sea level. Indicated and inferred reserves above sea level were estimatimated to be 2,025,000 cubic yards of bituminous sandstone, weighing 3,512,000 tons, and containing 1,311,000 barrels of bitumen.

Platinum

The *Mendocino Mining and Milling Company, Incorporated* was organized in 1920 to mine a gravel deposit near Hopland, in secs. 21, 28, T. 13 N., R. 11 W., M. D., for gold and platinum. According to Logan (1918, pp. 44-48) gold and platinum occur in a layer of gravel 1½ to 3 feet thick overlying a sandstone gravel which has occasional lenses of clay and shale. The gravel includes boulders and pebbles of schists, greenstones, quartz, serpentine and jasper. It is derived from the Franciscan formation and from serpentine and later intrusives piercing the Franciscan. A plant with equipment designed to handle 350 tons of gravel per day failed to recover gold and platinum in paying quantities and it was shut down after two days operation and later dismantled. In 1924, Lloyd C. Ashley of Alameda worked the deposit on a small scale for a while (Averill, 1929, p. 466) and a small production of platinum was reported. The distribution of both gold and platinum was very irregular.

Quicksilver

The *Occidental (Amrillo, Amarillo, Wise's) mine* is located in Lot 39, NE¼ sec. 6, T. 12 N., R. 11 W., M. D. about 7 miles southwest of Hopland. Bradley (1918, p. 71) stated that some work was done on this property in 1875 and again for several years preceding 1907. The only definite record of commercial output is 50 flasks in 1906. No work has been done since then and most of the workings are now caved. The ore was said to be on ocherous, weathered serpentine material associated with opaline silica in a brecciated formation.

Sand, Gravel and Crushed Rock

The production of sand and gravel for concrete construction and for building and repairing roads was the principal mining industry in Mendocino County in 1952. In 1950, 254,413 short tons of sand and gravel worth $263,487 were produced. In 1952 there were three plants operating on bars on the Russian River in the vicinity of Ukiah. Screened and washed sand and gravel and ready-mix concrete were produced at two plants and hot asphalt road-mix at two plants. A sand and gravel screening plant and a ready-mix concrete plant have been operated on Fullwider Creek east of Willits since 1947 and the contractor placing hot asphalt road mix on Highway 101 just south of Willits obtains his sand and gravel from Outlet Creek near Longvale.

The *Ford Gravel Company* owned by Milton Ford and Edward Walsh of Ukiah operates a crushing and screening plant and a concrete batching plant on the west bank of the Russian River about 1½ miles northeast of Ukiah in sec. 9, T. 15 N., R. 12 W., M. D. The pit material consisting principally of quartz, chert, greenstone, and sandstone is derived from the Franciscan group which crops out over most of Mendocino County. The gravel is dug to a depth of 20 feet with a Unit dragline equipped with a ½-cubic-yard bucket. It is loaded onto a DW-10 Carryall of 7-cubic yards capacity and hauled a short distance to the screening plant where it is dumped through a 6-inch spaced bar-grizzly into a hopper. Material over 6 inches in size is crushed to minus 1½ inches in a jaw crusher and dropped onto a belt conveyor which discharges it over a double deck shaking screen fitted with 1½-inch, ¾-inch and ¼-inch screens. The sand and gravel is washed with sprays above the screen and the

FIGURE 3. Concrete batching plant at the Ford gravel pit near Ukiah.

separate sizes slide to belt conveyors which carry it to stockpiles. The screened material is loaded from stockpiles into 4- and 5-cubic-yard capacity dump trucks with a Wagner scoopmobile fitted with a $\frac{3}{4}$-cubic-yard bucket. A Quickway Model-E crane mounted on a White truck is also used to load trucks or to dig drainage ditches and to lift heavy equipment. Much of the sand and gravel dug here is used for concrete aggregate in a Blair & Knox batching plant located on the site. This plant has mixed up to 600 cubic-yards of concrete aggregate in 12 hours. Deliveries are made with five Ready-mix trucks of $4\frac{1}{2}$- and 5-cubic-yards capacity. The plant has been operated at this site since 1947. Eleven men are employed.

Sid Jones and Tom Caldwell of Ukiah operate a hot asphalt road-mix plant on the east bank of the Russian River south of Ukiah in sec. 28, T. 15 N., R. 12 W., M. D. A D-4 Caterpillar bulldozer is used to push the sand and gravel from the pit to the elevator of a portable screening plant. The elevator discharges the material over a shaking screen which is fitted with a $\frac{3}{4}$-inch screen. The oversize is stockpiled. The minus $\frac{3}{4}$-inch material is loaded into 5-ton capacity dump trucks with a pushmobile loader fitted with a $\frac{1}{4}$-cubic-yard bucket. It is hauled a short distance and dumped into the hopper of a Madsen Iron Works hot asphalt road-mix plant. The asphalt is heated to about 300 degrees Fahrenheit in a cylindrical tank and mixed with heated minus $\frac{3}{4}$-inch gravel and sand in proportions as specified. The plant has a capacity of 150 tons in 8 hours. All the product is used to build and repair roads. Deliveries are made in 5-ton dump trucks. The plant is operated by a crew of three men.

Harms Brothers of Sacramento operate a gravel pit on Outlet Creek about 2 miles southeast of Longvale in sec. 5, T. 19 N., R. 14 W., M. D. The material includes pebbles of standstone, greenstone, quartz, chert

and diabase derived from the Franciscan group. The gravel, 2 to 4 feet deep and overlying a silt bed, is excavated with a Caterpillar Carryall of 12 cubic-yards capacity and stockpiled above the steel hopper of a Cedar Rapids portable screening plant. The screening plant separates the material into $1\frac{1}{4}$-, $\frac{3}{4}$-, and minus $\frac{1}{4}$-inch sizes which are stockpiled. The minus $\frac{3}{4}$-inch material is loaded into trucks with a Hough loader and hauled about 10 miles to a Standard Steel Corporation 3,000 pounds capacity batch mixer located at Willits. There, a penetrating paving asphalt is heated in a cylindrical tank to about 300 degrees Fahrenheit and mixed with heated minus $\frac{3}{4}$-inch aggregate in a pug mill. The oil and aggregates are weighed and mixed in the proportions specified. Deliveries are made with 5-cubic-yard dump trucks. All the material is used on U. S. Highway 101.

C. A. Haun and Son, Rt. 1, Box 105, Willits, operate a sand and gravel plant and a ready-mix concrete batching plant about a mile east of Willits in sec. 17, T. 18 N., R. 13 W., M. D. Sand and gravel consisting principally of pebbles of quartz, chert, greenstone, sandstone and gabbro derived from the Franciscan rocks are dug from Fullwider Creek. The material is dug to a depth of 12 to 14 feet to a layer of silt with a Byers dragline fitted with a $\frac{1}{2}$-cubic-yard capacity bucket. Three 5-cubic-yard capacity dump trucks haul the material a short distance and dump it into the hopper of a screening plant. It is drawn from the hopper through a 10- by 20-inch jaw crusher onto a belt conveyor which discharges it over a Symons $3\frac{1}{2}$-deck shaking screen set above a six-compartment wooden bunker. The sand and gravel is washed as it is screened into $1\frac{1}{2}$-, 1-, $\frac{1}{2}$-, $\frac{3}{8}$-, and minus $\frac{1}{8}$-inch sizes. Most of the material screened is used in a Noble concrete batching plant. It has a 300 barrel capacity cement silo and 100 ton capacity aggregate bin. Stockpiles of the screened materials are maintained at the plant. Delivery of the batched concrete is made with a Yaeger $4\frac{1}{2}$-cubic-yard capacity ready-mix truck. The plant is operated by C. A. Haun, his son, and two men.

The *Ukiah Gravel and Cement Company, Incorporated*, John Freitas president, operates a sand and gravel screening plant, a concrete batching plant and a hot road-oil plant on the east side of the Russian River about a mile southeast of Ukiah. The location is described as being part of Lot 43, Yokayo Rancho and is in sec. 28, T. 15 N., R. 12 W., M. D. projected. The sand and gravel consists principally of quartz, greenstone, sandstone, gabbro and chert derived from the Franciscan formation which crops out over most of Mendocino County. The gravel is dug with a Northwest Model 25 dragline equipped with a $\frac{1}{2}$-cubic-yard bucket which has holes drilled in its sides to drain off the water. The material is loaded by dragline into 5-ton capacity dump trucks and hauled about half a mile to the screening plant. There it is dumped into a hopper through a rail grizzly. The oversizes slides into a Symons jaw crusher set to crush to minus $1\frac{1}{2}$ inches. The undersize from the hopper and jaw crusher slides to a belt conveyor and is discharged into a trommel on top of a four-compartment wooden storage bin. The trommel separates the material into four sizes from $1\frac{1}{2}$ inch to sand. All the material is washed by sprays as it moves through the trommel. The separate sizes are discharged into the appropriate wooden storage bins or can be trans-

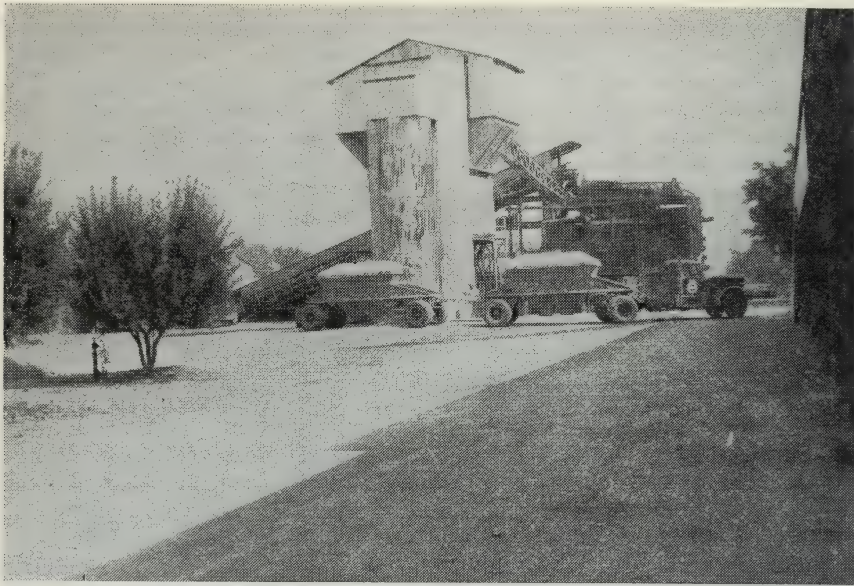

FIGURE 4. Concrete batching plant and gravel screening plant of the Ukiah Gravel and Cement Company near Ukiah.

ferred onto a belt conveyor and delivered to the bins of a Guntert and Zimmerman Transmix plant. This plant has four steel bins each having a capacity of 40 cubic yards. Two bins are used for sand, one for $\frac{3}{4}$-inch, and one for $1\frac{1}{4}$ inch size material.

Two steel cement silos 9 feet in diameter provide storage for 600 barrels of cement. All materials are weighed into the batching plant to comply with job specifications. Deliveries are made with three transit-mix trucks of $3\frac{1}{2}$- and $4\frac{1}{4}$- cubic yards capacity. A maximum of 225 cubic yards of concrete mix has been delivered in 8 hours.

Electric power to operate this plant is obtained from the Pacific Gas and Electric Company or it can be generated on the site by a Westinghouse generator which can be driven either by a Caterpillar D-13,000 diesel engine or a Sterling diesel engine. A machine shop is equipped with a lathe, drill press and an electric welder.

A hot road-oil plant is operated in connection with the sand and gravel plant. It includes two 8,000-gallon and one 10,000-gallon capacity tanks for penetrating road-oil which is used for armor coating roads. The oil is heated by steam coils to about 300 degrees Fahrenheit. Deliveries are made in a Telford 1,250 gallon capacity tank truck. The plant has a capacity of about 4,000 gallons of hot oil per day. The plants are operated under the supervision of John Freitas and his son, Ernest. From five to seven men are employed.

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TABULATED LIST OF MENDOCINO COUNTY MINERAL DEPOSITS

Mendocino County mineral deposits are listed in alphabetical order by commodity in the following table. The number in the first column refers to the map, plate 10 in pocket.

References given in the last column refer to the bibliography accompanying this report. Only the last name of the author is given. The first number after each name is the abbreviated date of publication as given in the bibliography; the second number, that following the colon, is the page reference.

ASPHALT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Point Arena Petroleum Oil and Coal Mining Company (California Bituminous Paving Company)	Leslie, Charlie and William Stornetto	3	12N	17W	MD	Beds of bituminous sandstone 20 feet thick were developed in several wells at Point Arena. They yield from 10 to 15 percent volatile matter. Idle. (Crawford, 96:36; Ireland 87:51; Lowell, 14:424-425; Jenkins and others, 43:77; Oakeshott 52:26; Stalder 43:77; Vander Leck 21:39-40; Weaver 43:628-632; Weber 87:200-202.)

BRICK AND TILE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Unnamed						Brickyards were operated at Mendocino, Talmadge and Ukiah at one time but there has been no production since 1944. The Mendocino State Hospital used brick manufactured from a deposit of gravelly silt at Talmadge. (Ashbury 06:375; Dietrich 28:126-127; Lowell 14:415.)

CARBON DIOXIDE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
1	Cal Dri Ice Corporation	Cal Dri Ice Corporation, 1168-70 Battery St., San Francisco Leasing from A.F. Moulton et al.	Lot 36 Sanel Rancho	13	11W	MD	Seven wells, 350 to 790 feet deep; dry ice plant manufactures about 10 tons of dry ice per day. (Hubbard 43:301-309; O'Brien 48:346-347)
	Gibson	Cal Dri Ice Corporation, 1168-70 Battery St., San Francisco Leasing from L.J. and Bess Gibson, Ukiah	20?	15N	12W	MD	Two wells drilled 235 and 435 feet deep. Liquid carbon dioxide plant. Idle. (O'Brien 48:347)
	Unnamed	Beattie Ranch	9	12N	11W	MD	A gas seep on Cumminsky Creek. Undeveloped. (Hubbard 43:30)

CHROMITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Big Red Mountain						See Guthrie group.
	Crawford		1	13N	12W	MD	Nine miles south of Ukiah; produced 2 tons in 1918. Idle. (Dow and Thayer 46:17)
	Filbin, O.B.		?	24N	16W	MD	O.B. Filbin of Potter Valley produced chromite from Red Mountain near Cummings in 1928. Idle. (Averill 29:462; Bradley 18:152)
	Graham group	Edward George	?	14N	11W	MD	Low-grade layered deposits; estimated possible reserves of 10,000 to 30,000 tons of 10 percent Cr_2O_3. Idle. (Bradley 18:154; 156; Dow and Thayer 46:17)
2	Guthrie group (Big Red Mountain, Mitty, Marie, Last Chance, Surprise)		18,19 20,29 30,32	24N	16W	MD	Mostly float in deep soil. More than 100 claims filed in 1918; 914 tons shipped to 1929. Idle. (Bradley 18:152-154; Dow and Thayer 46:18-19)
	Last Chance						See Guthrie group.
3	Little Red Mountain (Dunn)	C.C. Kirk et al.	5	23N	16W	MD	A lens of massive chromite about 2 feet wide; high-grade disseminated ore sparsely exposed in trenches. Idle. (Bradley 18:156; Dow and Thayer 46:19)
	Lloyd		35	23N	15W	MD	Nearly inaccessible, undeveloped, idle. (Dow and Thayer 46:19)
	Marie						See Guthrie group.
	Mitty						See Guthrie group.
	Moore		24	15N	13W	MD	Mined out; 15-20 tons of high-grade ore produced. Idle. (Dow and Thayer 46:19; Lowell 14:420; McGregor 90:313)
	Red Mountain Creek	C.C. Kirk et al.	NE$\frac{1}{4}$24	24N	17W	MD	Located July 1, 1950. Undeveloped.

CHROMITE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Shields	Probably abandoned	11	23N	11W	MD	Twenty tons of float ore collected; none shipped; nearly inaccessible. Idle. (Bradley 18:156; Dow and Thayer 46:19)
	Sugar Pine	Charles C. Kirk et al.	5	23N	16W	MD	80 acres located August 20, 1948, undeveloped. Idle.
	Summit						See Graham group.
	Surprise						See Guthrie group.
	United Nations	C.C. Charles, et al.	$E\frac{1}{2}NW\frac{1}{4}$ 29	24N	16W	MD	80 acres of placer located July 1, 1951. No production has been recorded. Idle.
	Unnamed deposit		$W\frac{1}{2}$ 1	23N	11W	MD	Float in landslide. Idle. (Dow and Thayer 46:19)

CLAY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Unnamed pits			15N	13W	MD	Common brick clays were mined at Mendocino and Ukiah prior to 1922; a deposit of gravelly silt at Talmadge yielded clay to manufacture brick used to build the Mendocino State Hospital. Idle since 1924. (Aubury 06:361-375; Averill 29:460; Dietrich 28:126-127; Lowell 14:415; McGregor 90:314.)

COAL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
4	Camp Carbon (Thomas) (Carbon Company)	Thomas Estate, Ukiah	SE$\frac{1}{4}$13 E$\frac{1}{2}$ 24 E$\frac{1}{2}$,NW$\frac{1}{4}$, N$\frac{1}{2}$SW$\frac{1}{4}$ 25	21N	13W	MD	A bed of sub-bituminous coal 12 feet thick; 450 foot shaft; 500 feet of drifts; many surface cuts. Idle. (Averill 29:460-461; Boalich 20:144; Crawford 94:56-58; 96:54; Goodyear 87:149,190; 90:317-320; Laizure 23:150-154; 24:87; Lowell 14:415; McGregor 90:314; O'Brien 48:348; Watts 92:255)
5	Eel River (Flood Estate)	Mineral rights are owned by Maud Lee Flood et al.	2	21N	13W	MD	See text. Idle. (Averill 29:461; Crawford 94:57-58; 96:54; Goodyear 90:317-320; Laizure 20:144; 23:145-150; Lowell 14:415-417; McGregor 90:314; O'Brien 48:347-348)
	Mount Vernon						See Round Valley
	Round Valley (Mount Vernon)	Mineral rights are owned by Maud Lee Flood et al.	E$\frac{1}{2}$11	21N	13W	MD	(Crawford 94:58; 96:54; Laizure 23:145-147; Lowell 14:416; McGregor 90:314; Weber 87:149). Idle.
	Thomas						See Camp Carbon.

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
6	Deep Hole (Eden Valley)		13	20N	12W	MD	Quartz and chalcopyrite; 40-foot shaft cutting three veins 4 inches to 1 foot. Idle. (Eric 48:271; Lowell 14:418)
	Eden Valley						See Deep Hole.
	McGimpsey		13?	13N	12W	MD	Copper stains in serpentine. Idle. (Aubury 05:136; 08:162; Eric 48:271; Lowell 14:419)
	Native Copper						On Red Mountain, 12 miles southeast of Ukiah. Native copper in serpentine shown in a shallow cut. Idle. (Aubury, 05:135; 08:161; Crawford, 96:59; 94:67; Eric, 48:271; Lowell, 14:418)
	Ogle	Alexander and Elizabeth Burger, Life Estate	30	13N	12W	MD	Gossan can be traced for a mile; carbonate ore is exposed in a shaft 16 feet deep; patented land. Idle. (Aubury 05:135; 08:161-162; Eric, 48:271; Lowell 14:419)
	Pieta		?	12N	10W	MD	Ten miles northeast of Cloverdale. Traces of copper carbonate and iron oxides exposed for a width of 55 feet between serpentine walls. Idle. (Aubury 05:136; 08:162; Eric 48:271; Lowell 14:419)
	Red Buck						See Red Mountain.
	Red Mountain (Red Buck, Salinas)		20?	14N	11W	MD	Ten miles southeast of Ukiah. Four claims located in 1890; several small bunches of copper carbonate and native copper found in cuts; shafts 100 feet and 50 feet deep; a ton of ore mined above the 50-foot level and shipped to San Francisco in 1896 netted $12.00; several tons of low-grade ore mined from inclines; idle. (Aubury 05:135; 08:161; Crawford 94:67; 96:59; Eric 48:271; Lowell 14:418-419)

COPPER CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Red Buck						See Red Mountain.
7	Redwood Copper Queen	Redwood Copper Queen Company, c/o E.R. Leach, 217 Hillside Ave., Piedmont	17,20	12N	13W	MD	Patented land; a mineralized zone 300 feet long, 10 to 40 feet wide, and 125 feet deep with kidneys and lenses of sulphide ore; largest lens was 75 feet long and 6 feet thick of iron sulphide with up to 9 percent copper; 400 tons shipped to a chemical plant in 1906 for manufacture of sulphuric acid. Idle. (Aubury 05:136-137; 08:162-163; Averill 29:462; Eric 48:271; Lowell 14:419-420)
	Salinas						See Red Mountain.
	Thomas	Henshaw Investment Co.	9	20N	12W	MD	Sulphides of iron and copper; no vein found. Idle. (Aubury 05:135; 08:161; Crawford 94:67; 96:59; Eric 48:271)
	Whipple prospect	Rawles family et al.	17	14N		MD	Thin seams of copper carbonate in shale exposed in an open cut 15 feet long and 10 feet wide; idle. (Averill 29:462; Eric 48:271)

GRAPHITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	McNab		?	13N	12W	MD	An undeveloped bedded deposit; discovered in 1903. Idle. (Castello 20:145)
	Western Graphite Company		8	12N	15W	MD	Graphite occurs as a blanket formation about 15 miles east of Point Arena. It was mined by quarrying, washed and puddled to free from quartz and sold for use as a paint, lubricant and foundry facings. Idle. (Aubury 06:280,364)

GOLD

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Boy Edgar		7?	14N	11W	MD	Five narrow quartz veins exposed in micaceous slate said to assay $4.75 in gold. Idle. (Crawford 94:176-177; 96:226; Lowell 14:420)
	Van Allen		?	15N	13W	MD	Two claims located 6 miles west of Ukiah; small stringers and irregular masses of quartz with pyrites; tough, blue glaucophane schist walls; inclined shaft 20 feet deep. A crosscut adit 170 feet through schist; idle. (Crawford 94:177; 96:226; Lowell 14:420)

JADE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Aztec Associated Placer	W.L. Taylor et al	?	24N	11W	MD	160 acres located June 21, 1951. Undeveloped. (Chesterman 52:1323)
	Burma Queen	W.L. Taylor et al	21?	24N	11W	MD	A lode claim located about 350 feet down the northeast slope from the second highest peak south of Leech Lake Mountain. Undeveloped. (Chesterman 52:1323)
	Covelo Jade, No. 1-2-3-4	Charles I. Stockton, G.H. Weise et al 3121 Ricks Ave. Martinez	21,22	24N	11W	MD	The nephrite variety of jade occurs as veinlets and irregular pods in the serpentine sills that intrude Franciscan graywacke and shales. (Chesterman 52:1323)
30	Jade Placers, No. 1-2-3-4	Charles I. Stockton, G.H. Weise et al	20,21	24N	11W	MD	Boulders of nephrite up to 12 inches in size are found in Williams Creek. (Chesterman 52:1323)
	Rangoon	W.L. Taylor, et al	21?	24N	11W	MD	A lode claim located in the Leech Lake district 350 feet down from the northeast slope from the second highest peak south of Leech Lake Mountain. Undeveloped. (Chesterman 52:1323)

LIMESTONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
8	Fisher Ranch	M.H. Fisher and Pauline C. Fisher, Laytonville	$E\frac{1}{2}$ and $NW\frac{1}{4}$ 36	22N	15W	MD	Limestone outcrops in two small hills east of the highway 13 miles from the railroad at Longvale; color is pink to yellowish gray; fine-grained hard, dense stone with subconchoidal fractures; parts of the deposit appear to be quite siliceous; no development or production. Idle. (Logan 47:253-254)
	Northwest Pacific Lime and Sulphur Company						See Quinan Ranch deposit.
	Northwestern Lime and Sulphur Company						See Quinan Ranch.
9	Quinan Ranch (Northwest Pacific Lime and Sulphur Company, Northwestern Lime and Sulphur Company)	Grace T. Post	26	17N	13W	MD	A terrace deposit of travertine and calcareous tufa deposited by springs; a pit 27 by 50 feet and 10 to 15 feet deep showed travertine 6 to 8 feet thick; material was used in agriculture; worked from 1930 to 1933; crushing plant located at Laughlin has been dismantled. Idle. (Averill 29:462; Logan 47:254)

MAGNESITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Hixon Ranch (Vassar Ranch)	Ancel E. and Zella Irene Fox	2,11	12N	11W	MD	An undeveloped deposit of magnesite reported 12 miles north of Cloverdale. Idle. (Aubury 06:328; Averill 29:462; Bradley 25:52; Lowell 14:422)
	Southard Ranch		?	18N	13 or 14W	MD	Two miles from the railroad at Willits. A ledge of magnesite 4 feet wide and 50 feet long was mined by open cut by J.C. Duffield and Chas. Whited of Willits; vein pinches to 10 inches at depth of 30 feet; hard serpentine walls; 150 tons shipped in 1916. Idle. (Bradley 25:52)

MANGANESE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Ash Hollow	George Lee Carrico	20?	24N	12W	MD	Manganiferous chert. No production. (Trask and others, 43:133; 50:112)
10	Bevins-Busch (Lee, Potter Valley)	H.A. Dickey et al.	3,10	17N	12W	MD	Typical Franciscan deposit; manganese oxides in red chert beds. Idle. (Averill 29:463; Boalich 20:145; Bradley 18: 40:42; Trask and others 43:133; 50:122)
	Big Bend		28	23N	11W	MD	Mostly float. No production. Idle. (Bradley 18:40; Trask and others, 43:133; 50:113)
	Big Jim						See Consolidated.
	Black leases						See Consolidated.
	Blands Cove						See McLaughlin.
11	Brereton (New Year, Old Country)		31	23N	11W	MD	Carbonate ore; oxide is mined out; small production World War I. Idle since. (Bradley 18:46; Trask and others, 43: 133; 50:113-115)
	Buck Ridge		17	15N	11W	MD	Typical Franciscan deposit. No production. (Trask and others, 43:113; 50:115)
	Busch						See Foster Mountain.
	Busch, Bevins						See Bevins-Busch.
	Callizo	Marie Hinds	SE$\frac{1}{4}$33	13N	12W	MD	Typical Franciscan deposit; a 6-foot bed of manganiferous brown chert exposed in a small cut; no production. Idle. (Trask and others, 43:134; 50:115)
	Cinco DeMayo		22	24N	11W	MD	A layer of brownish gray to pinkish carbonate ore parallel to thin-bedded chert. No production. Idle. (Trask and others 43:134; 50:116)
	Cleveland (Homestead)	Charles H. and John	13	16N	12W	MD	A small kidney of black oxide has been exposed by an open

MANGANESE CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Cleveland (Homestead) (continued)	Foster Guntly					cut on a contact of jasper and black shale. Considerable float. No production. Idle. (Bradley 18:42; Lowell 14: 421)
	Consolidated (Black leases,) Big Jim, Love Indian, Mount Sanhedrin	A.G. Hauer	30	20N	11W	MD	A small production of siliceous oxide and manganiferous chert. Idle. (Bradley 18:45-46; Trask and others, 43:134; 50:116-118)
	Cooper	Edward W. and Mabel B. LeBaron	33	12N	11W	MD	Property was worked in 1918. Some ore on dumps; main bed is estimated to contain 30 percent manganese; small production in 1918. Idle. (Trask and others 43:134; 50:118-119)
	Coursey Bros.		4	18N	13W	MD	Manganiferous chert and manganese oxides occur in narrow seams and veins in thin bedded red chert. No production. Idle. (Trask and others, 43:134; 50:119)
	Dorn	William A. and Roy O. Fahle	S$\frac{1}{2}$,SE$\frac{1}{4}$ 28	19N	12W	MD	Small fragments and blocks of soft oxide ore surround leached chert. Small production. Idle. (Trask and others, 43:134; 50:119)
	Faucher		22	17N	12W	MD	Three tons of ore containing 50 percent manganese and 5 percent silica were mined from a massive chert bed. Typical Franciscan deposit; small production. Idle. (Trask and others, 43:134; 50:119-120)
	Fischer	Cora M. Fischer	9	17N	12W	MD	The files of U.S. Geological Survey 1918 state that the deposit has little value. May be the same as the A. Fisher deposit which follows. Idle. (Trask and others, 43: 134; 50:120)
	Fisher (A. Fisher)	Fisher	9	17N	12W	MD	Thin bedded radiolarian chert stained with black manganese oxide; no ore developed. Idle. (Trask and others, 43: 135; 50:120)

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
12	Foster Mountain (Independent, Busch, Lucky Boy)	L.P. Dodson, Jr., et al	SE¼ 3, NE¼ 10	18N	12W	MD	A typical Franciscan deposit; production about 300 tons of 47.5 percent manganese and 23.8 percent silica was mined in 1944 from cuts and adits in thin-bedded chert. Idle. (Averill 29:463; Boalich 20:145; Bradley 18:42-44; Laizure 43:55; Trask and others, 43:134; 50:120-123)
	Fredrica						See Heughes.
	Graham		?	20N	14W	MD	A typical Franciscan deposit; very small; no production. Idle. (Trask and others, 43:134; 50:123)
	Guthrie						See Spy Rock.
	Hale		24	12N	11W	MD	Five tons of brown manganiferous chert piled on the dump. A typical Franciscan deposit. Idle. (Trask and others, 43:135; 50:123)
	Happy Four						See Long, Earl W.
	Harms	Leona Eddie et al.	NE¼ 34	19N	12W	MD	A thin bed of high-grade black oxide ore, averaging 4 inches thick with siliceous black oxide ore containing much white and red chert. No production. Idle. (Trask and others 43:135; 50:123-125)
	Heughes (Fredrica)	W.K. Ford	NE¼ SE¼ 27	17N	12W	MD	A thick lens of massive chert cut by numerous veinlets of black manganese oxide; no shipping grade. Idle. (Trask and others, 43:135; 50:125)
	Hinrichs	Joseph & Emmalie Kopf	SW¼ 22	19W	12W	MD	Blocks of low grade manganiferous chert in red soil. No ore in place. Samples assayed 19.5 percent manganese and 11 percent silica. Idle. (Trask and others, 43:135; 50:125)
	Homestead						See Cleveland.

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Hopper		16	17N	11W	MD	Manganiferous chert; no production. Idle. (Bradley 18:44; Trask and others, 43:136; 50:126)
	Hurt, Rhodes and						See Rhodes and Hurt.
	Impassable Rock (Rhodochrosite, Mount Sanhedrin)		SW$\frac{1}{4}$, NE$\frac{1}{4}$31 NE$\frac{1}{4}$6	20N 19N	11W 11W	MD MD	Small amounts of carbonate ore exposed; no production. Idle. (Bradley 18:44-45; Trask and others, 43:136; 50:126)
	Independent						See Foster Mountain.
	Jump Off Creek		32	23N	10W	MD	About 50 tons of ore are exposed in a small fault block. Idle. (Trask and others, 43:136; 50:126)
	Knight	Ralph C and Barbara J Neary	25 and 30	18N 18N	14W 13W	MD MD	Siliceous oxide ore is exposed in a bed 2 to 3 feet wide associated with white chert. Idle. (Trask and others, 43:136; 50:126-127)
	Last Chance						See Long, Earl W.
	Leap		11	22N	15W	MD	Three small pits sunk on a manganese stained outcrop; manganese is associated with iron oxide in schist; low grade; no production. Idle. (Trask and others, 43:136; 50:127)
	Lee						See Bevins-Busch.
	Leech Lake Mountain, Line Gulch		16 or 21	24N	11W	MD	A good grade of carbonate ore undeveloped; no production. Idle. (Bradley 18:44; Trask and others 43:137; 50:127)
	Leona		NE$\frac{1}{4}$27	17N	12W	MD	A typical Franciscan deposit. Production of 100 tons recorded. Idle. (Trask and others, 43:137; 50:127)
	Liberty	Judge Bell Williams et al.	SW$\frac{1}{4}$15	17N	12W	MD	Small fissures in red chert are filled with manganese oxide. Idle. (Trask and others, 43:137; 50:127)

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Linser	Chester Linser	NW$\frac{1}{4}$ SW$\frac{1}{4}$32	5S	5E	H	Produced 2500 tons of sorted ore averaging 35 percent manganese by August, 1944. Idle. (Trask and others, 43:137; 50:127-128)
	Lone Fir	Joe Scott	SW$\frac{1}{4}$19	22N	11W	MD	Undeveloped location. Idle.
	Lone Indian						See Consolidated.
	Lone Tree		20?	14N	11W	MD	Brecciated float ore; no production. Idle. (Trask and others, 43:137; 50:129)
	Long, Earl W. (Woodman Station, Happy Four, Last Chance)	Evan F. Rohrbough	12	22N	14W	MD	A typical Franciscan deposit; no production. Idle. (Boalich, 20:146; Trask and others, 43:137; 50:129-130)
	Long, F.J.		1	24N	14W	MD	A typical Franciscan formation; a small production. Idle. (Trask and others, 43:137; 50:130)
	Lucky Boy						See Foster Mountain.
	Mathews and Shaw						See Shaw and Mathews.
	McClendon Ranch		1?	16N	12W	MD	A typical Franciscan deposit; small production. Idle. (Bradley 18:44; Trask and others, 43:136; 50:130)
	McLaughlin (Blands Cove)		26	24N	11W	MD	Typical Franciscan deposit; no production. Idle. (Bradley 18:40; Trask and others, 43:138; 50:131)
	Michaels, Roman and Weeks		23 and 30	23N	11W	MD	Low grade manganese oxide in chert outcrop along a zone several hundred feet long; about 30 tons mined in 1948. Idle. (Bradley 14:44; Trask and others, 43:138; 50:132)
	Montezuma Improvement Co.		?	23N	14W	MD	Manganiferous chert, no production. Idle. (Trask and others, 43:138; 50:132)

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Morrison	M.G. Morrison	1	22N	12W	MD	A typical Franciscan deposit. Idle. (Trask and others, 43:138; 50:132-133)
	Mount Sanhedrin						See Consolidated, Impassable Rock.
	New Year						See Brereton.
	Nowlin	Hal and Christine S. Schultz	3	22N	13W	MD	Bands of oxide and carbonate ore 2 to 7 feet thick enclosed in thin-bedded red radiolarian chert, exposed in open cuts and stopes; a small production. Idle. (Trask and others, 43:138; 50:133-134)
	Ocean View	Henshaw Investment Co.	NE$\frac{1}{4}$34	20N	12W	MD	A little manganese oxide occurs in fracture cracks in a body of greenstone, no production. Idle. (Trask and others, 43:138; 50:134-135)
	Old Country						See Brereton.
	Pieta Creek						See Pine Mountain.
	Pine Mountain (Pieta Creek)		25,26	12N	10W	MD	Low-grade, siliceous manganese oxide in thin-bedded brecciated red and brown chert; exposed in landslide and in open cut, no production. Idle. (Boalich 20:146; Trask and others, 43:139; 50:135)
	Potter Valley						See Bevins - Busch
	Rhodes and Hurt		W$\frac{1}{2}$36	23N	12W	MD	A small amount of low-grade manganese ore float found with pieces of red chert; no development. Idle. (Bradley 18:46; Trask and others, 43:139; 50:135-136)
	Rhodochrosite						See Impassable Rock.
	Roman						See Michaels, Roman, Weeks.

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Rose	Vera M. Whittaker	21	20N	14W	MD	A few tons of siliceous ore were mined from an open cut; associated with red chert. Idle. (Trask and others, 43:139; 50:136)
	Round Mountain						See Thomas.
	Rowlison		14?	20	13W	MD	A prospect 3 miles south of Farley station; black oxide ore is exposed on a slope resembling a landslide; no production. Idle. (Trask and others, 43:139; 50:136)
	Salinger	Donald L. McFarlane	SW¼ 13	13N	11W	MD	A bed of manganiferous chert 1 foot thick exposed in a trench 30 feet long; no ore of shipping grade. Idle. (Trask and others, 43:139; 50:137)
	Scott	L.P. Dodson, Jr. et al.	NE¼ 10	18N	12W	MD	A thin seam of clayey manganese oxide between vertical beds of jasper and chert, no production. Idle. (Trask and others, 43:139; 50:137)
	Shaw and Mathews	Edward W. and Mabel Le Baron	33	12N	11W	MD	Two carloads of ore averaging 47 percent manganese and 12 percent silica mined from cuts in 1918. Idle. (Aubury 06:337; Bradley 18:83; Crawford 94:330; 96:507; Laizure 26:338; Lowell 14:333; McGregor 90:675; Trask and others, 43:140; 50:137)
	Shell Rock		12?	23N	15W	MD	Six miles west of Spy Rock Station; manganese occurs in lenses interbedded in jasper; no production. Idle. (Bradley 18:46; Trask and others 43:140; 50:137)
	Skaggs Springs						Location is unknown; a production of 457 tons reported during World War I; deposit may be in Sonoma County. (Trask and others, 43:140; 50:137)
13	South Thomas	Iva V. and Raymond H. Travis	NE¼ 27	17N	12W	MD	Two parallel beds of manganese in well-bedded red chert; J.R. Thomas reported that about 1500 tons of black oxide

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
13	South Thomas (cont'd)						ore was shipped from this mine. Idle. (Trask and others, 43:140; 50:137-139)
	Spy Rock (Guthrie)		?	23N	15W	MD	Irregular lenses of siliceous ore in chert; 20 tons assayed 33.4 percent manganese and 34.7 percent silica. Idle. (Bradley 18:46; Trask and others, 43:140; 50:139-140)
	Star		25?	24N	11W	MD	No commercial ore found except for a few pieces of carbonate float. Idle. (Trask and others, 43:140; 50:140)
	Summer Camp	Henshaw Investment Co.	27	20N	12W	MD	This deposit is too high in iron and silica and too low in manganese to be of economic importance. Idle. (Trask and others 43:140; 50:140-141)
	Thatcher Creek		23	21N	11W	MD	Siliceous manganiferous iron ore occurs in greenstone; no commercial ore found. Idle. (Bradley 18:46; Trask and others, 43:140; 50:141-142)
14	Thomas (Round Mountain)		22,27 34,35	17N	12W	MD	A production of 6,230 tons of 50 percent manganese, and 7 to 10 percent silica is reported from this property; mined from open cuts and adits. Idle. (Averill 29:463; Boalich 20:145; Bradley 18:46-48; Lowell 14:421; Trask and others, 43:141; 50:142-145)
	Two Trees		NW$\frac{1}{4}$32	24N	10W	MD	Oxide and carbonate float ore and blocks of manganiferous chert in an area where slides have been numerous; no production. Idle. (Trask and others, 43:141; 50:145-146)
	Ukiah						A deposit near Ukiah is listed in the files of the U.S. Geological Survey for 1918. The location is not known. (Trask and others, 43:144, 50:146)

MANGANESE, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Usal	Sage Land & Lumber Co.	1,2, 26, 35,36	23N 24N 24N	18W 18W 18W	MD MD MD	Manganiferous iron oxide deposit replacing limestone; low grade; no production. Idle. (Trask and others, 43:141; 50:146-147)
	Waldteufel						See Wild Devil.
	Weeks						See Michaels, Roman, Weeks.
	Wild Devil (Waldteufel)		$N\frac{1}{2}$15	17N	12W	MD	Manganese ore 6 feet wide was developed in a trench 18 feet long, 10 feet wide and 10 to 20 feet deep; well bedded red chert exposed on both walls. Idle. (Averill 29:463; Boalich 20:145; Bradley 18:48-49; Trask and others, 43:141; 50:147-148)
	Wishbone		16?	20N	14W	MD	About 2 miles north of the Rosemine. A bed of psilomelane 1 to 2 feet thick is exposed for 6 feet; associated with red chert; no development. Idle. (Trask and others, 43:141; 50:148-149)
	Woodman Station						See Long, Earl W.
	Young		28	19N	13W	MD	Lenses of oxide ore separated by lenses of red chert and shale are exposed in cuts. Idle. (Trask and others, 43:141; 50:149-150)

MINERAL PAINT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Heughes		27	17N	12W	MD	A red rock thought to be suitable for paint making is found on this property. Idle. (Averill 29:463; Boalich 20:146; Symons 30:154)
	Unnamed						A large deposit of ferruginous rock is said to occur at Red Mountain, about 6 miles south of the Humboldt County line. It has been used as paint by many settlers in that area. Idle. (Watts 92:256)

MINERAL SPRINGS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	California Seltzer Springs						Sparkling carbonated water flows from a spring 12 miles north of Cloverdale. (Averill 29:463; Crawford 94:338; 96:512; Lowell 14:423)
15	Duncan Mineral Springs	Katherine Marie Ashbrook	SE$\frac{1}{4}$25	13N	12W	MD	Five mineral springs with water containing lime, soda and magnesia with free carbonic acid gas located $1\frac{1}{4}$ mile southwest of Hopland. Operated as a resort. (Averill 29:463; Crawford 94:338; 96:512; Lowell 14:44; McGregor 92:313)
	Garby's						One mile west of Ukiah; a small alkaline spring has dried up. (Crawford 96:512; Lowell 14:424)
	Gobbi						A small undeveloped alkaline spring at the base of the foothills one mile west of Ukiah. Now dried up. (Averill 29:464.)
	Lane's	Thomas Lane, Calpella					In Redwood Valley, near Calpella; the water has an alkaline taste; undeveloped. (Crawford 96:512; Lowell 14:424.)
	Ornbaum	L.S. Ornbaum	4	12N	13W	MD	Located on the edge of a small valley at the source of Garcia River and Ranchers Creek; cold highly carbonated water. Resort is now closed. (Averill 29:464; Boalich 20:146.)
16	Orr's Hot Springs	C.E. Weger	SE$\frac{1}{4}$ NW$\frac{1}{4}$24	16N	14W	MD	Three springs in a narrow canyon of the South Fork of Big River, 14 miles northwest of Ukiah at 1,000 feet altitude; the hot sulphur spring has a temperature of 106°. Operated as a resort with hotel accomodations. (Averill 29:464; Boalich 20:146; Crawford 96:512-513; Lowell 14:423-424; McGregor 90:313.)
	Point Arena Hot Springs		W$\frac{1}{2}$25	12N	15W	MD	Located about 15 miles southwest of Point Arena. Two

MINERAL SPRINGS, CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Point Arena Hot Springs (cont'd)						springs flow $1\frac{1}{2}$ and 3 gallons per minute of sulphur water 110 degrees in temperature. Opened as a resort in 1910 and had accommodations for 100 guests in 1910. It has been closed in recent years.
17	Vichy Springs	Arnold G. and Henry O. Erickson	11	15N	12W	MD	Water issues from a bed of calcareous tufa 15 to 20 feet thick; 3 springs, one cold and two warm water, contain soda, lime, magnesia with carbonic acid gas; in Doolan Canyon, 3 miles northeast of Ukiah. Operated as a resort. (Averill 29:464; Boalich 20:146; Crawford 94:338-339; 96:513; Lowell 14:422; McGregor 90:312-313.)

NATURAL GAS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Austin Muir	William Donald Muir	?	18N	13W	MD	"Austin Muir, Willits, has been using natural gas for many years from a well 200 feet deep on his place three miles east of Willits" (Averill 29:464; Boalich 20:147)
	Unnamed	Hiram Willits, Willits	?	18N	13W	MD	Some gas has been found at Casper Creek. Hiram Willits at Willits, bored a well for water 75 feet deep and struck a small flow of gas. (Weber 87:185)

NICKEL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bell Valley mine	Theo. S. and Earl A. Ford	4	13N	13W	MD	Sulphides in red and brown chert ore said to have given returns in nickel but the showing is so small that it is unlikely that anything of importance will be developed; idle. (Averill 29:464)

ONYX

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Unnamed						Onyx marble occurs in Gravel Valley. (Aubury 06:114)

PLATINUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
23	Mendocino Mining and Milling Company, Inc.		21,28	13N	11W	MD	Equipment capable of digging and processing 350 tons of gravel in 24 hours was installed to extract gold and platinum in 1920; it was not a success and the plant was dismantled; the deposit has been idle except for occasional brief small-scale operations. (Aubury 06:347; Averill 29:446; Boalich 20:147; Haley 23:153; Laizure 24:87; Logan 18:44-48.)

PETROLEUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
18	Brandstein and Silverberg		11	12N	17W	MD	A hole drilled to a depth of 780 feet in 1918 was bottomed in Miocene. Tar sands were logged from 522 to 715 feet. Abandoned. (Oakeshott 52:26; Vander Leck 21:40)
19	Fresno Co. (?) John D. Well	Hunter Ranch	11	12N	12W	MD	A well drilled 1700 feet deep in 1910 may be bottomed in Franciscan. Abandoned. (Oakeshott 52:26; Vander Leck 21:40)
20	Keyt, N.F.	Leslie, Charlie and William Stornetta	3	12N	17W	MD	Hole drilled in 1941 to a depth of 1738 feet. Thought to have bottomed in Miocene. Abandoned. (Oakeshott 52:26)
21	Mendocino Coast Oil Co.	Mendocino Coast Oil Company, Robbins	11	12N	17W	MD	A hole drilled 2240 feet deep at this location in 1905 was bottomed in Monterey shale. Abandoned. (Oakeshott 52:26; Vander Leck 21:40)
	Mendocino-Midway Syndicate No. 1		30	19N	13W	MD	A hole was drilled in 1925-26 to a depth of 2174 feet. Thought to be bottomed in Franciscan. Abandoned. (Oakeshott 52:26)
	Point Arena Land Company Kyte 1	Leslie, Charlie and William Stornetta	3	12N	17W	MD	Located just inside the edge of the sea cliff $1\frac{1}{2}$ miles northwest of Point Arena. Drilled in 1940-41; abandoned. (Jenkins and others, 43:632; Oakeshott 52:26; Weaver 43:628-632)
22	Twin States Oil Company Soldani 1	Joe and Margaret Soldani	14	12N	17W	MD	A hole drilled in 1932 to a depth of 7632 feet was bottomed in harder rock beneath Oligocene; probably Cretaceous. Abandoned. (Oakeshott 52:26; Stalder 43:77; Weaver 43:632)
	Watson Oil Company		2	12N	17W	MD	A hole drilled 700 feet deep on the Curley Ranch about $1\frac{1}{2}$ miles northwest of Point Arena was bottomed in asphaltum. A second well drilled a short distance west on the Porter O'Neal ranch was abandoned between 600 and 700 feet. (Jenkins and others, 43:77,163,632; Vander Leck 21:39-40; Watts 00:158)

PETROLEUM CONT.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	White Lumber Company						Three wells were located about 100 yards northwest of the ship loading chutes. The wells were abandoned in asphaltum. (Watts 00:158)

QUICKSILVER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
24	Occidental, (Occident, Amvilla?, Amarillo, Wise's)	Arthur L. Dobie mineral rights to James G. and Ella B. Cortelyou	Lot39, N½ 6	12N	11W	MD	The ore is in an ocherous weathered serpentine; 50 flasks produced in 1906; idle since. (Averill 29:467; Bradley 18:71; Ransome and Kellog 39:401.)

SAND AND GRAVEL

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
25	Ford Gravel Company	Milton Ford, Edward Walsh, et al.	9	15N	12W	MD	Gravel is dug from the west bank of Russian River; screening and ready mix concrete plant also operated at this location.
26	Harms Brothers	Harms Brothers, Sacramento	3	19N	14W	MD	Sand and gravel is dug from Outlet Creek and screened; minus 3/4 mesh material is hauled to an asphalt mix plant at Willits; product is all used on Highway 101.
27	C.A. Haun & Sons	C.A. Haun, Rt. 1 Box 105, Willits	17	18N	13W	MD	Gravel is dug from Fullwider Creek; screened sand and gravel plaster sand and Ready-Mix concrete produced.
28	Jones and Caldwell	Jones and Caldwell	Part of Lot 9, Hastings suburban addition Ukiah				Gravel is dug from the east bank of the Russian River and used to make a hot asphalt mix in a plant at this location.
29	Ukiah Gravel and Cement Company	Ukiah Gravel and Cement Company, Ukiah	Part of lot 43 27	15N	12W	MD	Sand and gravel mined from a bar on the Russian River; screening plant; concrete batching plant; hot oil mix plant. (Averill 29:467; O'Brien 48:348-349)

SANDSTONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Unnamed		16 1	15N 14N	13W 13W	MD MD	A heavy ledge of yellow-gray sandstone of excellent quality crops out on the headwaters of Orr's Creek 6 miles west of Ukiah, and also on Roberts Creek, 5 miles southwest of Ukiah. (Crawford 96:636; McGregor 90:314)

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ANTIMONY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
1	Desert Antimony	Mrs. W. Trehearn, Nipton Mercantile Co., Nipton	18	16N	14E	SB	East Clark Mountain area. (Tucker 30:204-205; 31:264-265; 43:429; pl. 7; herein.)
	Desert Antonomia	E.C. Agnew. 3804 So. Vermont Ave., Los Angeles	21	13N	16E	SB	Lanfair Valley, south of Ivanpah. Prospect. No production. Idle.
	Mountain Pass Antimony	Sam Small, 405 So. Hill St., Suite 417, Los Angeles (1941)		16N	13E	SB	East Clark Mt. One mile north of Mountain Pass. Stibnite in silicified zone 4 to 5 ft. wide. Traceable for length of claim. Yielded 2 tons of ore prior to 1941. Total production small. Idle.

COPPER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
2	Allured (Erisman)	Allured Mines Corporation. Major E. Allured. secretary 6233-B Benson St., Huntington Park. Leased to John F. Erisman, Cima.	21,22	15N	14E	SB	Ivanpah Mts. (Eric 48:297; Newman 23:611; Tucker 30:205; 31:265; 43:430, pl. 7; herein.)
3	Amazon	F.H. Cline, Oro Grande (1930)	15	6N	4W	SB	Silver Mt. district east of Oro Grande. Copper oxides along limestone-diorite contact. Shafts 265 and 175 ft. deep from which 300 tons of ore were shipped prior to 1920. Long idle. (Bailey 02:11; Cloudman 19:784; Crawford 94:69; 96:60; Eric 48:297,305; Storms 93:363; Tucker 30:205-206; 31:265.)
	American Eagle						See New American Eagle. (Aubury 08:337; Cloudman 19:784; Eric 48:297; Tucker 30:206; 31:266; 43:430, pl. 7.)
	American Flag						See under gold.
	Anchor						See New Trail (Eric 48:298.)
4	Azurite (Blue Bonnet)	Undetermined	22,27	32S	47E	MD	Lane Mt. 12 miles south of Goldstone. Copper-stained aplite dike along shear zone in weathered granite. Explored for 400 yds. along strike by 80 ft. inclined shaft and surface pits. Production undetermined. Long idle.
5	B. and B. (Jackass)	Robert C. Buch and Elmer E. Mitchell, 851 W. Main St., Barstow	4,5 8,9	11N	1W	SB	Sixteen miles south of Goldstone. (Eric 48:308; herein.)
	Bagdad Chase						See under gold. (Eric 48:298.)
	Big Butte						See Copper Gulch. (Cloudman 19:785; Eric 48:299; Tucker 30:206; 31:266.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Blacet						See Blue Ribbon. (Eric 48:299.)
	Black Diamond	J. Scheerer estate, Victorville (1943)	3	6N	4W	SB	Silver Mt. district east of Oro Grande. Gold, silver, copper mineralization along contact between porphyry dike and granite. Explored by 150-ft. shaft and several shallow cuts. Long idle. (Cloudman 19:785; Eric 48:299; Tucker 30:206; 31:266.)
6	Black Metal	W.H. Ballinger, 309 Bank of America Bldg., Glendale	23	3N	26E	SB	Whipple Mts. Chrysocolla and horn silver present in 3 veins. Mined by 91-foot shaft and 131-ft. adit. High-grade ore produced prior to 1890. Most recent activity 1941-1942. Idle since. (Crawford 94:376; 96:606; Eric 48:299; Tucker 30:206; 31:266.)
7	Black Mountain	Black Mt. Mining Co., Nick Johriess, pres., Needles (1919)	36	10N	21E	SB	South end Dead Mts. west of Needles. Large group of claims. Long idle. (Cloudman 19:785; Eric 48:299; Tucker 30:206; 31:266.)
8	Black Mountain	John L. Watts estate, Raymond Watts, admin., 1119 Knoll Dr., Monterey Park	19,20	6N	7W	SB	West slope Black Mt. Has been incorrectly described as in Los Angeles Co. Malachite in narrow veins along contact between granite and metamorphic rocks. Vein strikes N.20°W., dip 75° W. Sulfide ore found at depth of 90 ft. in 100-ft. vertical shaft. A 30-ft. shaft sunk about 600 ft. to the south. Production small. Owner reports recent exploration indicates tungsten ore in tactite zone along granite-limestone contact. (Eric 48:299; Sampson 37:175; Tucker 27:289; 43:430,431, pl. 7.)
	Blue Bell (Hardluck)	F.C. Baker, Barstow. Leased to Roy V. Waughtel, Manix	27(?)	14N	7E	SB	In Soda Mts. west of Baker. See under lead-silver-zinc.
	Blue Bonnet						See Azurite.

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
9	Blue Cloud	Blue Cloud Copper Co., Mrs. Elizabeth C. Campbell and associates, 2233 La Mesa Dr., Santa Monica	26	2N	25E	SB proj.	South slope Whipple Mts. about 5 miles north of Earp. Rhyolite dike in pre-Cambrian metamorphic rocks. Dike strikes N. 30° W. dips 50° SW; 3 to 12 ft. wide. Brecciated zones in dike cemented with specular hematite and thin seams and coatings of chrysocolla. Mineralized zone at southwest end explored by short adits and shallow cuts. About 1000 ft. to northwest vertical shaft with reported depth of 300-400 ft. Some exploration work by lessees in 1950. Production very small.
	Blue Grass						See Riley under tungsten
	Blue Jacket						See Hermit
10	Blue Ribbon (Blacet)	Wesley Blacet, Pomona (1943)	3,4	4N	5E	SB	West of Emerson dry lake. A persistent group of narrow quartz stringers in granite porphyry; strike N. 70°-75° W., dip 80°S.; carry small proportion of copper sulfides. Developed by 100-ft. vertical shaft and 10-ft. drifts at 60 ft. and bottom. Several shallow pits to the southeast. Idle. (Eric 48:299; Tucker 43: pl. 7.)
	Braintruster	Harry Maddux, Beaumont	29	3N	24E	SB	West slope of Whipple Mts. Porphyritic dikes cut schist and carry azurite, malachite, and chalcopyrite. Assays of 5-10 percent copper, and $8 per ton in gold reported from 1 to 2 ft. width of dike. Development includes 80-ft. shaft with 15 ft. crosscut west to the vein at the 50-ft. level. A prospect. Idle.
	Break of Day						See Three States (Eric 48:300.)
	Brilliant						See Ord Mountain mine. (Eric 48:300; Tucker 30:217; 31:276; 40:239.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
11	Bumper group	C.H. and H.A. Norton, Needles (1930)	30	7N	23E	SB	North end Chemehuevis Mts. south of Needles. Malachite and azurite reported. Explored by 22-foot shaft and 65-foot adit. Long idle. (Cloudman 19:785; Eric 48:300; Tucker 30:206-207; 31:266.)
	Calarivada	Colosseum Mines Corp. (1930)	11	18N	13E	SB	North of Clark Mt. Quartz vein 2 to 4 ft. wide in limestone carries azurite, malachite, silver chlorides, and gold. Explored by 200-ft. shaft and 200-ft. of drifting on 100-ft. and 200-ft. levels. Production undetermined. Long idle. (Eric 48:301; Tucker 24:93; Tucker 30:207; 31:266-267.)
	California Gold and Copper						See Von Trigger (Cloudman 19:785; Tucker 30:207; 31:267.)
	Camp Vera group	W.J. Rodgers, Barstow (1902)		30S	46E	MD	Morrow district, 25 miles north of Barstow. Copper minerals along a mineralized belt 500 ft. in maximum width; several miles long. Explored by many shallow shafts as much as 100 ft. deep, exposing granitic country rock. Sample of ore reported smelted in 1902 showed 18 percent copper and $4 in gold. Production undetermined. Long idle. (Aubury 02:252-253; 08:334; Cloudman 19:785; Eric 48:301; Tucker 30:207; 31:267.)
	Chase	See Bagdad					See Bagdad Chase under gold.
12	Claw Hammer group	Jens Youngreen Estate, Los Angeles (1940)	9,10	8N	1E	SB	North end of Ord Mts. south of Daggett. Copper oxides in zone 4 to 12 ft. wide along fractures in quartz monzonite near contact with rhyolite. Long idle. (Eric 48:302; Tucker 30:207; 31:267; 40:234.)
	Colorado						See New Trail.
	Colosseum						See under gold. (Eric 48:302.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Confidence Copper						See under tungsten.
13	Copper Basin	C.L. Dunbar, Parker Dam (1943)	4	2N	26E	SB	Whipple Mts., 1 mile north of Monument Peak. (Eric 48:302; Newman 23:308; 23:99-100; Tucker 30:207-209; 31:267; 43: 431-432, pl. 7; herein.)
	Copper Bell group	Humphrey & Bowman, Parker, Arizona (1913)	10	2N	25E	SB proj.	Monumental Peak district north of Parker, Ariz. Quartz veins in granite carrying copper, gold and silver minerals. Over 1000 ft. development. Activity not recorded since small production in 1913. (Eric 48:302; Tucker 21: 339; 30:209; 31:267-268.)
	Copper Butte						See Copper Gulch.
	Copper Chief	Copper Chief Mining Co., Goffs. Operated by John R. Butler, Goffs (1930)	36	10N	18E	SB	Near Goffs. Gold, silver, copper. Mined in 1930 through 80-ft. inclined shaft. Production small. Idle. (Eric 48: 302.)
14	Copper Commander	Ivanpah Copper Co., Dr. L.D. Godshall, pres., 722 So. Oxford Ave., Los Angeles	6	16N	13E	SB	Southwest slope of Clark Mt. Mineralized zone 200 ft. wide at granite porphyry-limestone contact. Contains malachite, azurite and copper oxides with very little sulfide mineralization. Explored by 140-ft. adit. Production undetermined. Adjacent to Copper World, which see. (Eric 48:302; Tucker 24:93; 30:209; 31:268-269; 43:433.)
15	Copper Gulch (Big Butte, Copper Butte)	E.F. Russell, Needles (1943)	28	9N	22E	SB	North end Sacramento Mts. west of Needles. Copper- and gold-bearing vein in granite. Strike northwest, dip vertical. Developed by 2 shafts, 125 and 600 ft. deep and by 2 adits. Ore reported to assay $3\frac{1}{2}$ to 8 percent copper and $6 to $11 per ton in gold. First shipment in 1940; one carload valued at $27 per ton. Idle since. (Cloudman 19:785; Eric 48:299; Tucker 30:206; 31:266; 43:432, pl. 7.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
16	Copper King	J. Riley Bembry, Cima	25	15N	13E	SB	Western Ivanpah Mts. Tactite zone along granite-limestone contact; bears seams of copper carbonates. Said to also contain scheelite, cassiterite and gold. Explored by 70° inclined shaft sunk prior to 1910, and reported to be 225 ft. deep. Other irregular shallow workings. No production. Idle.
	Copper Mountain	Copper Mountain Mining Co., San Bernardino (1908)	12	6N	4W	SB	Silver Mt., east of Oro Grande. Oxidized vein bearing limonite copper oxides and sulfides with some gold and silver occurs in limestone and quartzite. Developed by 5 shafts from 30 to 200 ft. deep and by about 100 ft. of level workings. Production undetermined. Idle many years. (Aubury 02:251; 08:333-334; Eric 48:303.)
17	Copper Queen	C.A. Remick, Needles	26	3N	22E	SB	Near Pyramid Butte between Turtle and Whipple Mts. Oxidized copper minerals in fissure zone in pre-Cambrian gneiss. Strike N. 20° E., vertical dip. Developed by vertical shaft, now caved but owner reports 40 ft. deep. No production. Idle.
18	Copper Queen	Paramount Mining Co., 1106 Isabel St., Burbank	30	14N	16E	SB	New York Mts. Copper-tungsten-zinc mineralization along nearly vertical contact between Goodsprings dolomite and Mesozoic quartz monzonite. Explored by 3 south-trending tunnels about 1000 ft. in combined length; highest several hundred feet above lowest. Small production, if any. (Eric 48:303.)
19	Copper Strand (Haney and Lee, Independence)	L.P. Haney, Barstow	9	6N	3E	SB	Southeast of Daggett on the northeast slope Fry Mts. Copper mineralization along contact zone, 300 ft. wide, between Mesozoic quartz monzonite and Paleozoic marble and quartzite. Several veins in zone strike N. 40° W., dip 50° SW. Veins carry copper carbonate, chalcopyrite and pyrite; outcrops traceable for 4500 ft. Developed by 600-ft. crosscut adit with 500-ft. inclined shaft near portal;

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
19	Copper Strand (continued)						600 ft. to north are 2 open cuts on footwall of zone. Ore treated at mill and leaching tanks, now dismantled. Property first operated 1900. Last production 1940. (Eric 48:303,308; Tucker 43:432; pl. 7.)
20	Copper World (Dewey Ivanpah, Ivanpah Copper, Old Ivanpah Copper Co.)	Ivanpah Copper Co., Dr. L. D. Godshall, pres., Standard Oil Bldg., Los Angeles. Leased to Collins & Assoc. 606 S. Hill St., Los Angeles.	6	16N	13E	SB	Southwest slope Clark Mt. (Aubury 02:254; 08:326-330; Cloudman 19:786; Crawford 94:69; 96:61; Eric 48:303; Tucker 21:339-340; 30:209; 31:269; 43:432-433, pl. 7; herein.)
	Creole						See Crystal under gold.
	Crystal						See under gold.
21	D. and W. (Dayton and Wilbur)	Esther F. Bonchart, Vidal	32 5	3N 2N	24E 24E	SB proj SB	Whipple Mts. about 1 mile southeast of the American Eagle. Vein 4 to 6 ft. wide containing oxidized copper minerals and gold is associated with quartz prophyry dike in pre-Cambrian gneiss. Explored by 750 ft. vertical shaft and over 5000 feet of underground workings. A 50-ton mill installed in 1913 but very little ore produced. Mill removed and shaft inaccessible. (Aubury 08:337; Cloudman 19:786; Eric 48:303; Tucker 30:210; 31:269.)
	Dayton and Wilbur						See D. and W.
22	Desert Butte group	Parks and Crowley, Barstow (1930)	16	3N	16E	SB	North end Iron Mts. east of Cadiz Lake. Copper, gold, silver, lead and zinc-bearing zone exposed to 45-ft. depth by 325-ft. tunnel. Small tonnage of complex ore reported shipped in 1914. Long idle. (Cloudman 19:786; Eric 48:304; Tucker 30:210; 31:269-271.)
	Dewey						See Copper World. (Tucker 43:433.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Dixie						See Juanita.
	Dutch Oven						See Von Trigger.
	Emperor						See Vulture. (Cloudman 19:816; Eric 48:304; Tucker 21:340-341; 30:210; 31:271; 43:pl. 7.)
	Erisman						See Allured. (Eric 48:305.)
	Evening Star						See under tungsten.
	Excelsior						See Riley under tungsten. (Eric 48:305.)
	Fayle	G.A. Fayle, Cima (1919)	12(?)	16N	13E	SB	Also see Blue Buzzard under lead-silver-zinc. In Mescal Range. Last operated 1917-18 when about 1100 tons copper-lead-silver ore produced. (Eric 48:305.)
	Foster Mines						See Glory and Grey Copper in this section and Dan Henrie under gold.
23	Francis	Francis Copper Mining Co., C. Colcock Jones, pres., 102 S. Occidental Blvd., Los Angeles	9	11N	14E	SB	Northeast end Providence Mts. Quartz vein (Cuyamaca) 6 to 30 ft. wide cuts gneiss and schist, and carries copper, lead, and zinc sulfides and some silver. Developed by shafts 70 and 140 ft. deep, and total of 600 ft. of drifts, on 70- and 140-ft. levels. No production since 1918 when about 300 tons of copper-silver ore were produced. (Eric 48:305; Jenkins 42:351; Kerr 46:164; Tucker 21:341; 30:210-213; 31:271-272; 43:434, pl. 7.)
	Garvanza						See under tungsten. (Eric 48:305.)
24	Giant Ledge	Giant Ledge Lead and Copper Co., R.J. Ingalls, 927 Palm Dr.,	31,32	15N	16E	SB	New York Mts. Massive quartz vein, 200 ft. in maximum width, along granite-limestone contact. Stained with copper oxides. Contains some base metal sulfides, hubnerite,

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
24	Giant Ledge (continued)	Colton					and scheelite. Explored by 1200-ft. crosscut, shallow shafts and open cuts. Hard Cash workings to north, near granite-limestone contact, explore fluorite, base-metal, and tungsten zones along fractures in limestone and granite. Possible small shipments in early 1900's. (Aubury 08: 333; Cloudman 19:786; Eric 48:305; Tucker 30:213; 31:272; 43:434; pl.7.)
25	Glory (Foster)	Paul G. McKenry, Nipton	14,15	17N	11E	SB proj.	Shadow Mts. northwest of Valley Wells. A series of parallel veins in schist carry copper minerals and gold and silver. Developed by 3 shafts 100 to 300 ft. deep. (Eric 48:305;306; Tucker 21:341; 30:210; 31:271; 43:434.)
26	Gold Banner	W.M. (Doc) Smith, Daggett	12,13	7N	1E	SB	Ord Mt. district, southeast of Daggett. Quartzose vein 4 to 10 ft. wide in gneissic granite bears copper carbonates, chalcopyrite, and barite. Exposed $\frac{1}{2}$ mile along strike. Developed by 200-ft. tunnel and 40-ft. inclined shaft which intersects tunnel 80 ft. from portal. Several hundred tons of picked ore shipped and milled in 1917; 1 carload shipped in 1941. Idle since. (Eric 48:306; Tucker 43:434, pl. 7.)
	Gold Coin						See Orange Blossom. (Eric 48:306.)
27	Gold Hill Copper	Harry Maddux and A.A. Baker, Beaumont	27	3N	23E	SB proj.	West edge Whipple Mts. (Herein.)
28	Gold Standard	Peter Hulsman, Vidal	36 1	3N 2N	23E 23E	SB proj. SB proj.	North slope Whipple Mts. Three parallel veins in pre-Cambrian gneiss, strike N. 40°-55° W., dip 70° NE.-SW., 2-4 ft. wide, carry auriferous oxidized copper minerals, principally azurite and malachite. Principal development along middle vein; consists of 140 ft. of trench in 2 sections plus 100-ft. vertical shaft. Other veins are explored by shaft and open cut. Operated intermittently by les-

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
28	Gold Standard (continued)						sees; production probably small. Idle.
29	Gold Trails	Charles Dunbar, Box 75 Parker Dam, and George Albrecht, Needles	31	3N	27E	SB	Whipple Mts., east of Copper Basin Reservoir. Oxidized copper minerals and free gold in several veins following fault zones in pre-Cambrian gneiss near contact with Tertiary volcanic rocks. Vein, 2 to 4 ft. wide, explored for few hundred ft. by drift adit, several pits and shallow inclined shafts. Another vein explored by 300-ft. adit. Property first worked 1937-40. Property first worked 1937-40. Property first worked 1937-40. Latest work by lessee in 1950 when 2 cars of ore were shipped. (Eric 48:306.)
	Gold Zone						See under gold.
30	Greenback	Harley Long, Victorville. Leased to Frank Parker, Box 202, Barstow	12	7N	1E	SB	Northwest Ord Mt. Copper carbonates and chrysocolla in oxidized quartz veins cutting gneissic granite. Lamprophyre and diorite dikes nearb . Developed by two shafts 50 ft. apart, 65 and 80 ft. deep, with minor level workings. First opened in 1898, with no recorded production, and reopened in 1939 with an acid-leaching process which proved impracticable. Active on small scale in 1952.
31	Grey Copper	Shadow Mountain Mines, Paul G. McKenry, pres., Nipton (Formerly part of Foster Mines Co. holdings)	15,16	17N	11E	SB proj.	Shadow Mt. west of Clark Mt. district. Shattered zone in diorite gneiss carries quartz and oxidized copper minerals. Explored by 100-ft. vertical shaft and several hundred feet of level workings. No production. Long idle. (Refer to Foster Mines, Tucker 43:434, pl.7.)
	Halloran Springs (Toltec)	Chas. A. Kellog, and C.V. Welch, Los Angeles (1930)	17	15N	10E	SB	Halloran Springs district east of Baker. Azurite, malachite, silver halides, and gold occur along a shear zone in andesite in granite country rock. Shallow surface development workings only, no deeper than 30 ft. Long idle. (Eric 48:307; Tucker 30:213; 31:273.)
	Haney and Lee						See Copper Strand.

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Happy Day						See Wyatt Earp.
	Hard Luck						See Blue Bell.
32	Hercules	R. Andrews, Bagdad (1930)	17	7N	11E	SB	Hikorum district, north of Bagdad. Carbonates and oxides of copper with some gold in fine-grained quartz porphyry dikes cutting granite and schist. Development includes 42-ft. shaft and several hundred ft. of open cuts. Reported shipment of 1400 tons of ore carrying $6 to $8 in gold prior to 1919. Long idle. (Cloudman 19:786-787; Eric 48:307; Tucker 30:213; 31:273.)
	Hermit (Blue Jacket)	H.L. Atwood, Oro Grande (1919)		6N	4W	SB	Silver Mt. district, east of Oro Grande. Iron, copper and silver minerals with calcite in quartz vein 4 to 8 ft. wide in dolomite. Developed by shafts 40 and 80 ft. deep, deep, 100 ft. apart. Small tonnage mined and treated prior to 1890. Relocated 1910, but idle since. (Cloudman 19:787; Crawford 96:606; Crossman 90:230; Eric 48:299; Irelan 88:500.)
	Hidden Treasure	A.L. Moorehead and W.F. Chausse, Goffs (1930)	24	10N	20E	SB	Western Dead Mts., northwest of Needles. Zone 2 to 4 ft. wide containing copper oxides, chalcopyrite, and pyrite along contact of granite and schist. Copper staining in porphyry dike 500 ft. wide explored by prospect holes and trenches. Development includes 160-ft. shaft. Production undetermined. Long idle. (Eric 48:307; Tucker 21:341; 30:213-214; 31:273.)
	Home	L.V. Root & Joseph Luxon, Needles (1930)	7	7N	11E	SB	Hikorum district, north of Bagdad. Copper oxides and traces of gold in quartz veins cutting granite. Workings limited to one 75-ft. shaft on the vein. Long idle. (Cloudman 19:787; Eric 48:307; Tucker 30:214; 31:273.)
33	Horn	Turtle Mountain Mining	32(?)	2N	21E	SB proj.	Southeast slope Turtle Mts. (Aubury 08:337; Eric 48:308;

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
33	Horn (continued)	Co., A. Otis Birch, 427 W. 5th St. Los Angeles and R.G. Van Horn, Box 547, Earp	5(?)	1N	21E	SB proj.	herein.)
	Independence						See Copper Strand. (Eric 48:308.)
34	Indicator	Peter Hulsman, Vidal (1943)	21	3N	23E	SB proj.	Western Whipple Mts. Malachite, azurite and chrysocolla in seams and irregular masses along a fissure in decomposed rhyolite. Explored by 80-ft. inclined shaft, shallow cuts. Idle. (Eric 48:308.)
35	Iron Cap	Jerry Korfist and Frank Curtis, Baker	35	19N	10E	SB proj.	Small copper workings. Idle for many years.
	Islander						See under gold.
	Ivanpah						See Copper World.
	Ivanpah Copper Co.						See Copper World.
36	Ivanpah Mammoth		14	15N	14E	SB	East slope Ivanpah Mts. south of Mountain Pass. Two veins one containing silver and copper the other copper and gold. Explored by 100-ft. shaft. Long idle. (Aubury 08:330; Cloudman 19:787; Eric 48:308; Tucker 30:214; 31:273.)
	Jachon	R.M. Dillingham, Barstow (1930)		12N	2E	SB	Paradise Mts. (?) northeast of Barstow. Oxidized copper ores and gold occur in 3 veins as much as 4 ft. wide in granite. Workings include 120-ft. inclined shaft and 60 ft. of drifts. Production undetermined. Long idle. (Eric 48:308; Tucker 30:214; 31:274.)
	Jackass						See B. and B. (Eric 48:308.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
37	Josie K	C.E. Kane, Needles (1919)	30	9N	22E	SB	Ibex district, west of Needles. Oxidized minerals of copper and gold in quartz vein at granite-rhyolite contact. Reported to assay $11 in gold and 14 percent copper. Explored prior to 1919 by shallow workings for 4000 ft. along strike. Long idle. (Cloudman 19:787; Eric 48:309; Tucker 30:214; 31:274.)
38	Juanita (Dixie)	Union Development Co., Boston, Mass. (1908)	33,34 35,36 4	29S 30S	45E 45E	MD MD	Morrow mining district, east of Randsburg. Copper sulfides and gold in talcose veins near granite-lime-stone contact. Explored by many shafts as much as 212 ft. deep. Production undetermined. (Aubury 02:253-254; 08:335; Cloudman 19:787; Eric 48:309; Tucker 30:214; 31:274; 43: pl. 7.)
39	L. & L.	L. & L. Mining Co., O.A. Lau, pres., Riverside (1940)	17	7N	3E	SB	Newberry Mts. south of Newberry. Series of quartz veins, 1 ft. to 3 ft. wide, containing malachite, azurite, bornite, chalcopyrite and silver and gold in diorite and monzonite. Reported assays as much as $15 in gold and 9 percent copper. Developed by 50-ft. inclined shaft (50°) and a 500-ft. crosscut tunnel. Production undetermined. Long idle. (Eric 48:309; Tucker 30:215; 31:274; 40:237.)
40	Lady Lou	J. Denair, Amboy (1909) Operator (1946), L. Stevenson	11	7N	11E	SB	North of Amboy near Orange Blossom. High grade copper-gold ore reported in 4-ft. vein trending northeast, dipping northwest. Latest development work 1946. (Aubury 08: 340; Eric 48: 309.)
41	Lake View	Undetermined	18	13N	7E	SB proj.	Soda Lake Mts. west of Baker. Chalcopyrite ore on lime-stone-porphyry contact explored by 50-ft. shaft and 600 ft. of tunnels. Long idle. (Eric 48:309; Tucker 30:214; 31:274.)
	Lakeview						See Nellie May. (Eric 48:309.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Leastalk (Leastock)	Leastalk Gold & Copper (Mining) Co., L.M. Gregory, mgr., 500 Frost Bldg., Los Angeles (1919)		15N	16E	SB	Barnwell-Vanderbilt district. Northern New York Mts. Vein in limestone-granite zone carrying silver, lead and gold. Total development about 500 ft. including two 150-ft. shafts. Production undetermined. Long idle. (Aubury 08: 330,336; Cloudman 19:787; Eric 48:310; Tucker 30:215; 31: 274.)
	Leastock						See Leastalk.
	Lewis and Shafer	Lewis and Shafer		10N	21E	SB	Northwest Sacramento Mt. Vein 3 to 6 ft. wide, between massive slate and granite, and porphyry walls reported carrying 20 percent copper associated with gold. Developed by about 225 ft. of workings including 75-ft. shaft and 50 ft. adit (Aubury 02:255; 08:336; Eric 48:310.)
	Liberty Copper Ledge	G.A. Childers, 128 N. Flower St., Los Angeles (1943)	2	6N	4W	SB	Silver Mt. north of Victorville. Sparse mineralization of copper carbonates with iron oxides in shear zones in fine-grained diorite. Explored by shallow workings. Active in 1933, 1935-1936, 1940. Idle since. (Eric 48:310.)
42	Little Mike	J.A. Alexander, Bakersfield. Leased to Roy V. Waughtel, Manix.	36	14N	7E	SB proj.	Northeast Soda Lake Mts., west of Baker (Herein.)
	Lucky Jim						See under silver. (Eric 48:310.)
	McClintock						See Vulcan under gold.
	Margaret N.	L.H. Langer and C.M. Nelson, Box 251, Montague	23	2N	26E	SB	Southeast Whipple Mts. Chrysocolla and malachite in fractured flat-lying sandstone underlying volcanic cover. Exposed along 20 ft. of outcrop and in several short adits. Idle.
	Mohawk						See under lead-silver-zinc.

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mohawk Zinc						See Nigger Mountain under lead-silver-zinc (Tucker 43:69.)
	Moonlight	S.B. Hubbard, Box 694, Kingman, Arizona	29(?)	10N	21E	SB	Dead Mts. Small showing of oxidized copper and carbonate minerals associated with basalt dike in shear zone in granite porphyry. Explored by several shallow pits and short crosscut adit. Long idle. (Eric 48:312.)
43	Nellie May (Lakeview)	W.H. Durall, 1056 S. Mansfield Ave., Los Angeles, and Ralph W. Klages, 10450 Wilsey Ave., Tujunga (1943)	2	7N	7W	SB	Western Shadow Mts. Copper mineralization in 1 ft.- to 2-ft. veins in granite-limestone tactite zone. Explored by adit, 100 ft. of tunnels and shallow pits. Idle. (Eric 48:309,312; Tucker 43:435, pl. 7.)
44	New American Eagle (American Eagle)	Pete Hulsman, Vidal	31	3N	24E	SB proj.	Whipple Mts. northwest of Vidal Junction. (Aubury 08:337; Cloudman 19:784; Eric 48:297; Tucker 30:206; 31:266; 43:430, pl. 7; herein.)
45	New Trail (Anchor, Colorado)	New Trail Mining Co., Mrs. H.I. Kent, pres., La Calino Ranch, Riverside. Leased to W.H. Hile, 95 Monterey Rd. So. Pasadena.	9,16, 21,22	15N	14E	SB	Ivanpah Mts. (Eric 48:298,312; Tucker 30:216-217; 31:275-276; 43:435, pl. 7; herein.)
	New York						See Sagamore. (Aubury 02:251; 08:331-332; Cloudman 19:788; Tucker 30:317; 31:276.)
	Nickel Plate						See under gold. (Eric 48:313.)
	Nigger Mountain						See under lead-silver-zinc. (Tucker 43:486.)
	Old Ivanpah Copper						See Copper World. (Eric 48:313.)
	Old Roth						See Virginia Copper.

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
46	Orange Blossom (Gold Coin, Orange Blossom Extension)	Harry J. Morgan, 2830 Broadway, Huntington Park	13,14, 23	7N	11E	SB	Northeast slope Bristol Mts. Vein trending northeast and dipping 65°-75° NW. carried copper, gold and silver. First production 1902. Same vein explored by 600-ft. shaft, with 5 levels, on the Orange Blossom and by 715-ft. shaft, with 5 levels, on the Orange Blossom Extension adjoining on the northeast. Over 10,000 ft. of underground workings. In 1913 mill erected on Extension, 500 tons of ore treated, but shut down after brief operation. Total production probably small. Long idle. (Aubury 08:338-340; Cloudman 19:788-789; Eric 48:306,313;Tucker 30:217; 31:276; 43:pl. 7.)
	Orange Blossom Extension						See Orange Blossom (Aubury 08:340; Cloudman 19:789; Eric 48:313; Tucker 30:217; 31:276; 43:pl. 7.)
	Ord						See Ord Mountain.
47	Ord Mountain (Brilliant, Ord, Osborn, Rio Vista)	Harvey J. Stevenson, 1231 Sunset Playa Dr., West Hollywood	12,13, 24	7N	1E	SB	West flank of Ord Mt. (Aubury 08:336; Cloudman 19:789; Crawford 94:234; 96:61,326; De Groot 90:528; Eric 48:313; Tucker 30:217-218; 31:276-278; 40:239; 43:133,435,436; herein.)
	Osborn						See Ord Mountain mine. (Cloudman 19:789.)
	Pacific						See Bagdad Chase under gold.
	Pacific Coast Mill and Mining Co.						See under gold.
	Painsville						See under gold.
	Pauper's Dream and Quidunc	R.L. Brooks, Yucaipa (1930)	4	2S	1W	SB	Southwest San Bernardino Mts. near Yucaipa. Gold and copper bearing quartz vein, 1 ft. max. width, in schist. Reportedly carries up to 4 percent copper and $4 to $8 in

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Pauper's Dream and Quidunc (continued)						gold. Developed by 30-ft. shaft and open cuts. Idle. (Eric 48:314; Tucker 30:219; 31:279.)
	Price group	A.C. Price and Milton McNiellan, Long Beach (1930)	27	6N	2W	SB	North Granite Mt. east of Victorville. Three barite veins, 3 to 5 ft. wide, with copper stains. Cut limestone. Associated with epidote zones. Developed by 35-ft. shaft, open cuts, and crosscut tunnel. Long idle. (Eric 48:315; Tucker 30:219-220; 31:279.)
48	Revenue Copper	Charles P. Hale, Nipton	4,9	15N	14E	SB	Ivanpah Mts. adjacent to New Trail mine. Vein 4 to 6 ft. wide and containing copper carbonates and oxides, bornite and chalcopyrite, follows porphyry intrusion in limestone. Developed by 70-ft. shaft, 100-ft. cross cut, and various caved level workings including 40-ft. drift on 70-ft. level and stopes on 40 and 70-ft. levels. From 1917 to 1919 four cars of ore shipped, reported to assay 25 percent copper and $7 per ton in gold. Total production probably small. Long idle. (Eric 48:315; Tucker 43:436, pl. 7.)
	Reward						Goldstone district. See under gold. Small lenses of copper ore, reported to assay 4 to 15 percent copper, in vein. Copper discovery explored by 112-ft. winze.
	Riley (Blue Grass, Excelsior, Standard No. 1.)						See under tungsten. (Jenkins 42:349; Tucker 41:585-586.)
	Rincon Mines Co.	H.W. McDowell, Parker, Arizona (1918)		4N	25E	SB	Monumental district, south of Needles. Five groups of claims near the Colorado River. Diorite and monzonite capped with basalt cut by porphyry dikes. Gently dipping veins $1\frac{1}{2}$ to 6 ft. wide carry copper carbonates and bornite. Two carloads of ore shipped prior to 1923 assayed 5 percent copper, $22. in gold. Development workings and total production undetermined. Long idle. (Eric 48:315; Newman 23:308-309, Tucker 30:220; 31:279.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Rio Vista						See Ord Mountain mine. (De Groot 90:528; Tucker 40:239.)
	Riverview						See Ethel Leona under gold. Listed as copper mine but principal production has been gold according to present owner.
	Roosevelt						See Wyatt Earp.
	Rosalia Mining Co.	Rosalia Mining and Milling Co., C.E. Kane, Needles, pres. (1919)		9N	22E	SB	Ibex district west of Khartoum near Josie K Mine. A prospect. Reported assay of $17 in gold and 4 percent copper from 60 tons of dump. Long idle. (Eric 48:315; Cloudman 19:790.)
	Rose						See under gold. Copper ore from pockets. Shipped separately. (Aubury 02:252; 08:334; Eric 48:316.)
	Run Over Consolidated						Name given to patented group when owned by California Gold and Copper Co. See Von Trigger. (Eric 48:316.)
49	Sagamore (New York)	H.B. Hollingsworth and associates, 1496 E. Grand Ave., Pomona	33,34	14N	16E	SB	In New York Mts. See also under lead-silver-zinc and tungsten. (Aubury 05:251; 08:331-333; Cloudman 19:788,790; Eric 48:316; Jenkins 42:350; Partridge 41:308; Tucker 30:217,220; 31:276,279, 43:67-68,436-437, pl. 7; herein.)
	Silver Dome						See under gold. (Eric 48:316.)
	Standard No. 1 (Standard)						See Riley mine under tungsten. Small output of copper ore shipped prior to 1919. (Aubury 08:330; Cloudman 19:790; Tucker 30:220; 31:279-280.)
50	Standard No. 2	R. Bailey Gill, Cima	19,30 24,25	15N 15N	14E 13E	SB SB	Ivanpah Mountains (Herein.)
51	Surprise	C.E. Ballard, J.A. Weilage and J.B. White,	28	9N	3W	SB	South extremity of Hinkley Valley, northwest of Hodge. Traces of secondary copper minerals in mica schist. Ex-

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
51	Surprise (continued)	Rte. 1, Barstow, c/o Sally's Cafe.					ploration begun in 1949, consists of 30-ft. shaft, about 50 ft. of level openings. No production.
	Thelma and Mammoth		25	14N	7E	SB proj.	Soda Lake Mts. west of Baker. Quartz veins in granite carry copper, gold and silver. Explored by shaft 10 to 20 ft. deep. Long idle. (Eric 48:318; Tucker 30:220; 31:280.)
	Three States (Break of Day)	T.R. Whelan, Percy McCabe, and C.Yake, Silver Lake (1919)	21	15N	7E	SB	Silver Lake district, northwest of Baker. Chalcopyrite ore associated with porphyritic and dioritic dikes in limestone. Few tons shipped prior to 1919, but little profit realized. Idle for many years. (Cloudman 19:791; Eric 48:300; Tucker 30:220; 31:280.)
52	Tip Top	W.N. Masters, et al, Pasadena (1894)	36 31	7N 7N	4E 5E	SB SB	Lava Beds district southwest of Pisgah. Opened 1890 as a silver mine but pockets of high grade copper ores later mined and shipped to Swansee, Wales. Mineralization along broad shear plane in quartz porphyry. Exposed length 150 ft. Copper minerals on footwall side of fault zone. Concentrated ore, averaging over 30 percent copper and-15 ounces of silver, was shipped. Developed and mined through several hundred feet of workings on 4 levels. Total production undetermined but over 70,000 ounces of silver produced prior to 1900; since then the mine has been idle. (Aubury 02:251; Crawford 94:69; 96:61; Eric 48:318; Storms 93:354-358; Tucker 30:285; 31:358.)
	Toltec						See Halloran Springs. (Eric 48:307.)
53	Trade Rat	Unknown	9,16	32S	47E	MD	Ten miles south of Goldstone. Two 60-ft. shafts, explore zone of pyrite-chalcopyrite mineralization in shattered diorite. Long idle.
54	Trio	H. Lias, Ivanpah (1943)	21,22	14N	16E	SB	Central New York Mts. Copper-bearing bodies, composed mostly of garnet, lie along fractures in limestone. None

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
54	Trio (continued)						appear more than 3 or 4 ft. in maximum width or more than 40 ft. long. Explored by few shallow shafts and adits. Perhaps yielded small tonnage of shipping ore in early 1900's. Idle for many years. (Eric 48:318; Tucker 43:437.)
	Tuscarora						See Ethel Leona under gold. Listed as copper mine, but principal production has been gold according to present owner.
55	Virginia Copper (War Eagle Copper, Old Roth)	S.G. Hubbard, Box 694, Kingman, Arizona, and Harry LeClair, Oatman, Arizona	10,15	3N	24E proj	SB	Whipple Mts. Copper-silver-gold mineralization associated with basaltic dikes in shear zone along contact between rhyolite and andesite. Several hundred feet of underground workings explore showings 1100 feet apart. Production undetermined. No work since 1920. (Eric 48:318.)
56	Von Trigger (California Gold and Copper Co., Dutch Oven, Runover, Consolidated, Von Trigor)	L.P. Scaroni, T.A. Twitchell, and Guy L. Goodwin, trustees, J. F. Goodwin Company, 6363 Wilshire Blvd., Los Angeles	2,10 11,15	11N	17E	SB	North of Goffs. (Aubury 02:251; 08:333; Cloudman 19:785; Eric 48:316,319; Tucker 30:207; 31:267; 43:66; 43:438, pl. 7; herein.)
	Von Trigor						Probably the same as Von Trigger even though the location in references below does not coincide with known location of Von Trigger (Aubury 02:251; 08:333.)
	Vulcan (McClintock)						See also under gold. (Eric 48:319; Tucker 43:137.)
57	Vulture (Emperor)	George Eckles, General Delivery, Baker	31	17N	13E	SB	Clark Mt. adjacent to Copper World Mine. Nearly 3000 tons copper-silver-lead ore produced 1915-1919 from ore bodies along granite-limestone contact. Idle since except for barren 200-ft. drift driven in 1944. (Cloudman 19:816; Eric 48:304; Tucker 21:340-341; 30:210; 31:271; 43:pl. 7.)

COPPER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	War Eagle Copper						See Virginia Copper.
58	Winifred Group	F.P. Seburn and brother Needles (1919)	29, 30	7N	11E	SB	Old Dad Mt. district north of Bagdad. Developed by 300-ft. tunnel and several winzes. Small tonnage of ore reported to assay 12 percent copper with high gold content. Shipped prior to 1919. Long idle. (Cloudman 19:791; Eric 48:319.)
59	Wyatt Earp (Happy Day, Roosevelt)	Undetermined	6	1N	25E	SB proj.	South slope Whipple Mts. Copper-gold ore in vein cutting small exposure of pre-Cambrian metamorphic rocks. Prospected by 3 shafts, 35 to 100 ft. in depth, only one of which has more than a few ft. of lateral workings. Production, if any, not known. Long idle. (Aubury 08:337.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Althea						See Embody. (Crawford 94:228; 96:319.)
60	Alvord	Dellosso Mining Co., Los Angeles, being purchased by Roy Waughtel, Manix	1,2, 12	11N	3E	SB	Alvords Mts. north of Manix. (Crawford 94:229; 96:319, 330; Eric 48:297; Irelan 88:499; Newman 23:63; Storms 93: 359-360; Tucker 30:222; 31:281; 40:53-54; 43:438-439, pl. 7; herein.)
61	Amargosa Gold Placers (Sharps Diggings)	Harry D. Mauger, Burbank, and Frank G. Howe Los Angeles (1943)	11,14 23,24 25	19N	4E	SB	Northwest of Silver Lake. Claims cover about 5 miles along Amargosa River. Finely divided gold occurs in unconsolidated sand and gravel lenses having depths of 40 ft. Prospected 1932-33 by H.F. Alexander Exploration Co. Average value 55¢ per yd. indicated by 1500 samples taken from shafts and drill holes. No production because of difficulty in recovering fine gold. Idle. (Tucker 43:439-440 pl. 7.)
62	America (American)	Clara C. Engelke and others, c/o Walter Alf, P.O. Box 36, Daggett	18, 19	4N	12E	SB	North slope Sheep Hole Mts. (Eric 48:297; Tucker 38:15; 40:54-55; 43:440, pl. 7; herein.)
	American						See America.
63	American Flag	Estates of W.G. McGough and J.F. Goodwin c/o J.F. Goodwin Co., Guy F. Goodwin, 6363 Wilshire Blvd., Los Angeles	35,36	12N	17E	SB	North of Goffs. Also copper. Northeastern extension of Von Trigger group; 11 claims patented 1913. (Tucker 43: pl. 7.)
	Anconada						See Sullivan No. 1. (Newman 23:265; Tucker 21:344-345; 30:222; 31:281.)
64	Apex	W.G. and W.O. Merkle, 1734 Pacific Ave., Long	35	7N	4W	SB	East flank of Silver Mts. Gold-silver-lead minerals reported in shear zone, striking N. 25° W. and dipping 50°

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP.	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
64	Apex (continued)	Beach					SW., in andesite. Explored by drift adit reported to be 300 to 400 ft. in length. Production undetermined. Idle. (Tucker 30:222; 31:281-282.)
	Arlington						See Santa Fe. (Bailey 02:6; Newman 23:30; Tucker 30:222-226; 31:282-286; 43:440,460-461, pl. 7.)
	Arlyngton						See Santa Fe. (Newman 23:742.)
65	Arrastre	Undetermined	9	32S	47E	MD	Ten miles south of Goldstone. Oxidized copper minerals in vein in diorite explored by shaft of undetermined depth. Arrastres still on property. Long idle.
66	Arrowhead (probably same as Gold Pin)	E.G. Lane. Leased to Harry Fischer and James L. McPherson. (1950)	16	15N	10E	SB	Halloran Springs district. Gold-bearing, siliceous zones in granitic rock. Inclined shaft, 100 or more ft. deep with short drifts. (Tucker 31:326-327.)
	Arrowhead Development Co.						See Supply in text. (Tucker 30:255; 31:315.)
67	Azucar	E.J. Hamptom, Daggett	19	8N	2E	SB	Northwest Newberry Mts. Gold-bearing quartz vein in fault zone near diorite and greenstone dikes in monzonite. Explored by 200-ft. vertical shaft (burned in 1951), a 135-ft. inclined shaft having 120 ft. of drifts, an adit now caved 40 ft. from portal, and surface trenchings. No production. Idle since 1945.
	B. and B.						See Pilot.
	Bagdad						See Bagdad Chase (Cloudman 19:815.)
68	Bagdad Chase (Bagdad, Camp Rochester, Chase, Pacific Mines, Roosevelt	Bagdad Chase Mining Co., George Manierre, pres., 3851 Santa Fe Ave., Los	7,8	6N	8E	SB	In the Stedman district south of Ludlow. Also copper. See also the Pacific Coast Mill and Mining Company, formerly the Barstow Metals Extraction Company herein. (Cloudman

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
68	Bagdad Chase (continued) Consolidated)	Angeles					19:790:815; Eric 48:298; Gardner 40:261-275; Tucker 21: 341-342; 30:218-219; 31:278-279; 38:15; 40:56-57; 40:232-233; 43:126-127; 43:440-441, pl. 7; herein.)
	Bailey						Probably same as Bluff and Western, which see.
69	Balanced Rock	Jacob Balian, 907 So. La Brea St., Inglewood	11	2N	2W	SB	San Bernardino Mts. north of Big Bear Lake. Two 350-ft. adits driven northwest along quartz veins in granite. No production.
	Barrett (Hammerback and Patterson)	California-American Mining Co., Dr. Orman Lutz pres. (1930)	18	12N	15E	SB	East slope Providence Mts. Quartz vein along fissure in granite. Auriferous pyrite with galena and chalcopyrite. Developed by two 100-ft. shafts and one 320-ft. shaft. Idle. (Eric 48:298; Tucker 30:226; 31:287.)
	Barstow Metals Extraction Company						See Pacific Coast Mill and Mining Co. and Bagdad Chase. (Tucker 34:322-323.)
70	Belmont	Belmont Mining Co., Dr. W. W. Ramsey, Stockton (1943)	29	14N	1E	SB	Goldstone district. Two parallel quartz veins in shale and schist. Main shaft sunk on footwall vein on 35° incline to 420 ft. About 1000 ft. of level workings on 4 levels. Small production by 1941. Idle since. (Tucker 24:46-47; 30:227; 31:287-288; 40:57; 43:441, pl. 7.)
	Big Four						See Victor (Cloudman 19:807; Eric 48:299; Tucker 40:57; 43:441, pl. 7.)
71	Big Horn (Contention, Investment, Mabel, Mable)	Paul Tobeler, 2466 E. 56th St., Los Angeles	20	9N	14E	SB	Southeast end Providence Mts. Quartz veins follow walls of series of parallel andesite dikes cutting quartz monzonite. Veins range in width from a few inches to 4 ft. and have moderate to steep westerly dip. Gold associated with pyrite. Contention shaft is vertical, 325 ft. deep with levels at 160 and 300 ft. which explore vein for about 550 ft. Mabel shaft, 2500 ft. northerly, is 140 ft. deep with

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
71	Big Horn (continued)						800 ft. of level workings on the bottom. Principal production 1918-19 stated to be about $100,000, all from ore exceeding $50 per ton in grade. Idle since 1937. (Cloudman 19:801; Eric 48:299; Tucker 21:349; 24:196-198; 30:243; 31:303-304; 40:58; 43:441-442, pl. 7.)
	Black Beauty	R.J. McCausland, 315 N. Swall Dr., Beverly Hills	32	6N	17E	SB	Old Woman Mts. Gold-silver mine. Last operated 1935. Small production.
72	Black Hawk	George H. Clapp, Sewickley, Penn. (1949)	7	30S	41E	MD	Southeast of Randsburg. (Brown 16:471; Crawford 96:187; Hulin 25:130-131; Tucker 23:166-167; 29:29; 33:292-293; 40:29; 49:214,254; herein.)
	Black Hawk						Northeastern San Bernardino Mts. See Santa Fe. Cloudman 19:797-798; Crawford 94:230; 96:320; Crossman 90:226; De Groot 90:523-525; Storms 93:364-365.)
	Black Hawk		19,20, 29,30	30S	41E	MD	Atolia district. See under tungsten.
	Bliss Providence (Providence)	H.C. Bliss, P.O. Box 66, Essex	16,17 (?)	9N	14E	SB	Southeast slope Providence Mts. Probably the Providence noted by Cloudman as being "15 miles south of Bonanza King". Gold-bearing veins in granitic rocks. Developed by several shafts; main shaft inclined to depth of 150 ft. with about 200 ft. of underground workings. Production undetermined but small. Idle. (Cloudman 19:827.)
73	Blue Eagle (Florence)	Blue Eagle Mining Co., Nicholas Aldo, pres., Master Builders Supply Co., 520 E. Lockford St., Lodi	19,20	6N	17E	SB	North slope Old Woman Mts. Three parallel veins in granite about 200 ft. apart dip steeply to the east. Free gold is associated with pyrite, arsenopyrite, galena and sphalerite. Development on west vein consists of 160-ft. shaft and 50-ft. shaft about 1000 ft. to north. Open cut on parallel vein about 1000 ft. south of main shaft. Ore ship-

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
73	Blue Eagle (continued)						ped to Burton Brothers at Rosamond; also treated in mill on property now dismantled. Principal activity 1935-39. Idle. (Tucker 40:58-59; 43:443, pl. 7.)
74	Bluff and Western	Charles Dunbar, Parker Dam	11	2N	23E	SB proj.	West slope, north end Savahia Peak. Probably same as Bailey mine. Narrow quartz vein, probably gold-bearing, in pre-Cambrian gneiss capped by Tertiary volcanic rocks. Explored for less than 50 ft. horizontally by workings on 4 levels through total vertical interval of less than 200 feet. Upper workings consist of short drift adit near a 50-ft. shaft sunk on vein. Lower workings consist of a 200-ft. crosscut adit driven N. 75° E. which [illegible] intersect vein. Intermediate adits and short stopes and cuts on vein. Production undetermined. Bailey mine last worked 1935.
	Boomerang						See Vanderbilt.
75	Branch	H.L. Short, Barstow (1935)	27	7N	4W	SB	Oro Grande district. Developed by workings from a 300-ft. adit and 70-foot shaft. Operated 1931-35. (Tucker 43:pl. 7.)
	Brannigan						See Brooklyn and Los Angeles. (Eric 48:300; Tucker 31: 289-290.)
76	Brannigan	Walter Thompson and assoc. 1010 Cadberry Rd., Whittier	26,27	13N	10E	SB	North of Old Dad Mt. (Tucker 31:324; 43:pl. 7.; herein.)
	Brick Consolidated						See Vanderbilt.
	Bronze						See under tungsten. Formerly lead-silver mine with some gold. Gold produced in 1934-35.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Brookland						See Brooklyn.
77	Brooklyn	Brooklyn Mining Co., Highland (1941)	36	1S	12E	SB proj.	South part Dale district. (Cloudman 19:802; Newman 23:221-222; herein.)
	Brooklyn and Los Angeles (Brannigan)						South part Dale district. Both properties described in reports on San Bernardino and Riverside Counties. The Brooklyn mine is probably in San Bernardino County and the Los Angeles in Riverside County. See Brooklyn mine herein. (Cloudman 19:802; Eric 48:291, 300; Newman 23:221-222; Tucker 30:227-229; 31:289-290; 34:321.)
78	Bullion Range	Bullion Range Co. Inc., Roger Dering, pres., Ludlow (1943)	7	6N	8E	SB	South of Ludlow. Adjoins Bagdad Chase on west. Gold ore in quartz-cemented breccia zone along rhyolite and monzonite contact. Developed by 120-ft. shaft inclined 32° from which a drift and winze system has reached a total inclined depth of 332 ft. Idle. (Tucker 40:233; 43:443, pl. 7.)
	Burcham						See under lead-silver-zinc and in general discussion of Calico district in silver section, herein.
	Calle de Oro						See Santa Fe. (Tucker 31:285.)
	Calmont	G.M. Benjamin, Amboy (1930)	24(?)	3N	13E	SB	About 19 miles southeast of Amboy. Quartz vein in granite, strike east, dip 70° S. Developed by 200-ft. shaft with level workings at 100 ft. and bottom. Ore reported to average $15 per ton. Idle. (Tucker 30:229-230; 31:290; 43: pl. 7.)
	Calumet						See Santa Fe. (Crossman 90:226.)
	Cambria						See Mollusk. (Cloudman 19:808; De Groot 90:531-532; Eric 48:301.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Camp Castle						See Golden Cycle. (Tucker 30:230; 31:290-291.)
	Camp Rochester						See Bagdad Chase.
79	Camp Rock Placer (Clark Diggings)	S.H. Clinedinst, Pasadena (1943)	28	7N	3E	SB	On southwest slope Newberry Mts. Placer gold in Recent alluvium. Prospected by shallow pits and trenches along a narrow drainage channel for about 1000 ft. Depth of gravel 2 - 25 ft. Gold content ranges from 25¢ to \$1.25 per yd. Worked by dry washers prior to 1932. Washing and screening plant erected 1932 and operated until Sept. 1933. Water from wells $\frac{1}{4}$ mile west of deposit. Idle. (Gardner 40:262; Sampson 32:254; Tucker 30:230-231; 31:291; 40:233; 43:443-444, pl. 7.)
	Carbonate						Oro Grande district. See under lead-silver-zinc.
80	Carlyle (Carlisle)	Mrs. Shaffer, Pomona	11,14	1S	12E	SB proj.	Dale district. Also lead-silver. (Cloudman 19:803; Eric 48:301; Tucker 38:15; 40:61-62; 43:444-445, pl. 7; herein.)
	Castle						See Golden Cycle.
	Center						See Morongo King. (Crawford 94:231; 96:320.)
	Chese						See Bagdad Chase. (Cloudman 19:815.)
	Christie		19	2N	3E	SB	Westerly workings from a 190-ft. vertical shaft connected with those of the Rose mine. Now part of Rose mine (Cloudman 19:796; Crawford 94:231; 96:320; Tucker 30:231; 31:291.)
	Clark Diggings						See Camp Rock Placer.
	Cliff						See Santa Fe. (Tucker 30:224-225; 31:284-285.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Clipper Mountain		14	7N	15E	SB	See Gold Reef. (Tucker 21:344,345; 43:pl. 7.)
81	Coarse Gold	Coarse Gold Mining Co., J. and Phoebe Stephan, Clyde Biddle, W.W. Weigel and R.H. Simpson, Fenner (1935)	32	9N	14E	SB	Southeast slope Providence Mts. and south of Big Horn mine. Gold-bearing quartz vein in granitic rock strikes N. 30° E., dips 70° SE ; 2 ft. wide. Developed by 75-ft. inclined shaft on vein; and 100 ft. of drifts on 70-ft. level; nearly vertical 50-ft. shaft about 500 ft. to the south. Ore shipped reported to average $26 per ton in gold. Idle. (Tucker 40:62-63; 43:445, pl. 7.)
	Coin Consumer	F.L. Jaymes, 3715 2nd St., Highway Highlands (1938)					Slate Range district, 42 miles northeast of Randsburg. Gold mine developed by 2 shafts, 150 and 80 ft. deep and about 250 ft. of drifts. Operated 1935-38. Idle.
82	Colosseum	Colosseum Mining and Smelting Corp., C.W. Gowman, pres., 7371 W. Sunset Blvd., Hollywood (1943)	10, 14	17N	13E	SB	North Clark Mt. district. Auriferous pyrite with chalcopyrite deposited along fractures in rhyolite plug intrusive into gneissoid granite and along the granite-rhyolite contact. Two ore bodies have been worked from 2 adits having a 177-ft. vertical interval. Underground workings total about 4000 ft. Ore was produced during periods 1929-32 and 1935-39. During 1938-42 exploration program included 5000 ft. of diamond drilling. Significant production. Idle. (Eric 48:302; Tucker 24:92; 30:231-232; 31: 291-292; 43:128-129; 43:446, pl. 7.)
	Columbia						See under lead-silver-zinc. Has yielded small amounts of gold during periods 1926-28 and 1937-38.
83	Contact	E.M. Reimiller, Twentynine Palms	20	1S	9E	SB	Near Twentynine Palms. Quartz vein strikes N. 40° E., dips 60° NW.; in schist near granite contact. Explored by 50-ft. open cut and 150 ft. shaft having drift on 50-ft. level. Selected ore treated by amalgamation and reported to have yielded $70 per ton. Operated 1933-35 and 1940. Idle. (Tucker 21:345.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Contention						See Big Horn. (Tucker 21:349; 24:196-198; 30:243; 31:303-304.)
84	Coolgardie Placers	Undetermined	2,3 4	11N	3W	SB	North of Barstow. Gold placer deposits worked by dry methods. First operated about 1900. Little activity since 1930's. Estimated total production to 1930 about $100,000. (Haley 23:156; Laizure 34:250; Sampson 32:253; 34:250; Tucker 30:232; 31:293.)
	Copper Basin						See under copper. During the mine's early history, gold was produced from near-surface enriched, oxidized zone, but no records are available.
	Copper Gulch						Copper-gold mine. See under copper.
	Creole						See Crystal.
85	Crystal	James H. Simpson, 1015 5th St., San Bernardino (1935)	22	4N	6E	SB	Southeast of Emerson Dry Lake. Gold-copper mine developed by several shafts 40 to 140 ft. deep. Leased briefly in 1941. Production small. Idle. (Eric 48:303.)
86	Cumberland (High Hope)	Harry Fredericks and Hugh Connell, Alhambra (1943)	25 30	6N 6N	2E 3E	SB SB	West slope Fry Mts. Ore discovered in 1900 and hauled to Old Woman Springs to be milled in arrastres. Quartz vein strikes north, dips 85° W.; in quartz monzonite. Vein 18 inches to 3 ft. wide carries free gold associated with hematite, pyrite, marcasite and chalcopyrite. Developed by 6 shafts from 50 to 135 ft. deep within 2000 ft. of strike length. Ore produced in 1939. (Tucker 40:63; 40:234; 43:447, pl. 7.)
87	Daisy	Undetermined	24	12N	1E	SB	East base of Paradise Mts. Vuggy quartz vein 5 ft. wide, in granite and altered schist. Explored laterally for about 200 ft. by shallow workings. Idle.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
88	Dan Henrie	Foster Mines Co., E.D. Foster, pres. (deceased 1946)	10,15	17N	11E	SB proj.	Shadow Mt. 9 miles northwest of Valley Wells. Gold ore, mined from 1900 to 1941 from quartz veins in gneiss and diorite. Extensive workings. Idle.
89	Darling	C.C. Darling, Ivanpah	2 35	14N 15N	16E 16E	SB SB	Central New York Mts.; bordering Vanderbilt property. Veins in Archean complex; explored for gold and base metals from 1923 to early 1930's. Veins strike northward and westward. Developed by 4 inclined shafts within 600 feet of each other; 265 to 55 ft. deep. Several hundred ft. of tunnels appended to southernmost (deepest) and northernmost shafts. Few tons gold ore shipped. Idle. (Tucker 30:232-233; 31:293.)
90	Davis-Mill-King	Herman Yocker, 840 Herald St., Redlands	36	4N	2W	SB	San Bernardino Mts. north of Big Bear Lake. Quartz stringer, 1 to 2 ft. wide, explored for 100 ft. along strike by trenches and a 40-ft. shaft inclined 30° E. Idle.
	Death Valley						See under lead-silver-zinc.
	Del Oro	Stanley Parker Mining Co., 817 Roosevelt Bldg., Los Angeles. Lessee (1950)	Approx	6N	4W	SB	Silver Mts. district. Gold-silver-lead mine. Worked from 200-ft. shaft. Ore produced during 1939-40 and in 1950. Production small.
91	Denver (Mitchell)	Joe Larrieu, Box 21, Fenner, and Leslie C. Walker, San Francisco	18	11N	17E	SB	East slope Hackberry Mtn. northwest of Goffs. Gold mine in Miocene volcanic rocks. Developed by shafts and nearly 500 ft. of adits and drifts. Gold ore produced 1930-31, 1938-39 and 1941. Idle since.
92	Doble (Gold Mountain, Lucky Baldwin)	James Hulmes estate, South Pasadena	25,36	3N	1E	SB	North of Baldwin Lake, San Bernardino Mts. (Crawford 94:232; 96:322; De Groot 90:523; Tucker 21:346-347; 30:237; 31:298; 40:66-67; 43:452-453, pl. 7; herein.)
	Dollar Bill						See Vidal Gold. Most active 1932-34 and 1936-37.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
93	Doulch No. 1	Lee Doulch, Victorville	1,2	3N	2W	SB	San Bernardino Mts. north of Big Bear Lake. Fractured quartz veins, as much as 1 ft. wide, in sheeted granite. Explored by two caved inclined shafts now 40 and 15 feet deep. Idle.
94	Dull Pick	W.H. Brown and W.T. Russell, Ludlow (1941)	18	6N	8E	SB	Stedman district south of Ludlow. Gently dipping, gold-bearing vein 4 ft. wide in brecciated monzonite porphyry near contact with dacite. Developed by 2 inclined shafts, sunk on the vein about 50 ft. apart and 180 ft. deep. Ore was treated in cyanide plant at Ludlow. Produced 1933-36, 1939-41. Idle since. (Eric 48:304; Tucker 40:235.)
	Eaton						See Dorris May under iron. (Tucker 43:469.)
	Elkhorn Mining Co.						See Silver Basin. See also Gold Basin under tungsten. (Tucker 30:233; 31:293-294.)
95	Elsie	Mrs. Florence Gilbert, Colton (1940)	25,36 31	6N 6N	2E 3E	SB SB	West slope of Fry Mts. southwest of Daggett. Quartz vein associated with andesite dike and cutting gneissic granite. Gold occurs with arsenopyrite, pyrite and copper carbonate stains. Developed by 2 shafts 250 and 150 ft. deep about 500 ft. apart. Active in early 1900's when output probably appreciable. Small production in 1935 and 1940; idle since. (Tucker 40:235.)
96	Embody (Althea)	Riverside Cement Co., 621 So. Hope St., Los Angeles	17	6N	4W	SB	Half a mile east of Oro Grande. Gold disseminated in schistose granite. Ore shoot limits not well defined. Explored by 2 shafts, 100 and 30 ft. deep. All work prior to 1890. (Cloudman 19:812-813; Crawford 94:228; 96:319; Storms 93:361; Tucker 30:234; 31:294.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
97	Emerson	Sarah L. Emerson, Hodge (1937)	15,22 (?)	4N	5E	SB proj.	West of Emerson Dry Lake. Seven parallel veins in Jurassic granitic rock strike NW., dip 70° SW. Principal development 412 ft. shaft, inclined 70°, and over 2,000 ft. of underground workings. Mill, now dismantled, on southwest edge of Emerson Dry Lake. Small total production from intermittent operation 1927-1938. Idle (Eric 48:304; Newman 23:63; Tucker 30:234; 31:294.)
98	Erwin	R.B. Stephenson and Jim Erwin, 1567 "G" St., San Bernardino	32	2N	2E	SB	San Bernardino Mts. south of Baldwin Lake. Pyrite in oxidized quartz vein in limestone and quartzite. Explored by adit about 150 ft. long. Idle.
99	Ethel Leona (Jarvis, Riv-view, Tuscarora)	R.G. Van Horn, Box 547, Earp	31	2N	25E	SB proj.	South slope Whipple Mts. northwest of Earp. Free gold and oxidized copper minerals in veins in pre-Cambrian metamorphic rocks. Explored by several shafts the deepest reported to be 300 ft; also a 180-ft. adit stoped to surface. Production of 200 tons reported; average grade 3.82 percent copper, $12.12 per ton gold. (Cloudman 19:791; Eric 48:315; Tucker 30:220; 31:280; 43:436, pl. 7.)
100	Evanna	Robert Curtis, Inglewood	1	3N	2W	SB	San Bernardino Mts. north of Big Bear Lake. Shear zone in weathered granite explored by shaft inclined 20° SW. and adits. Production small. Idle since 1941-42.
	Exchequer	Undetermined		1S	11E	SB proj.	Small gold mine in Dale district. Developed by 3 shafts 40 to 110 ft. deep. Idle. (Cloudman 19:803; Tucker 30:234-235; 31:295; 43: pl. 7.)
	Florence						See Blue Eagle.
	Four Brothers (Whatnot)						See under tungsten. Yielded gold prior to 1896. Reopened and operated 1909-1916. Total output small.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
101	Fremont Peak (Gateway)	Mrs. W.O. Walker	33,34	31S	42E	MD	Southeast of Atolia. Series of parallel quartz veins in Jurassic quartz monzonite and along contacts between quartz monzonite and and rhyolite dikes. Veins contain gold, pyrite and arsenopyrite. In general, veins strike northeast, dip steeply northwest and range in width from 1 to 4 ft. Principal workings a 185 ft. inclined shaft with 3 levels and about 3250 ft. of drifts and crosscuts. Property also contains 3 adits 60 to 200 ft. long. Amalgamation mill on property. Idle. (Tucker 23:172; 30;235; 31:295; 34:324-325; 43:447-448, pl. 7.)
102	Frisco	P. Thebadeau, Kelso (1931)	10 (?)	11N	14E	SB	West slope Providence Mts. 7 miles east of Hayden. Gold associated with pyrite in east-striking quartz veins in granitic rock near contact with Archean metamorphic rocks. Developed by several shafts 20 to 100 ft. deep and adits 200 to 400 ft. long. Production small. Long idle. (Eric 48:305; Tucker 30:235; 31:295-296.)
	Gateway						See Fremont Peak. (Eric 48:305.)
	Giant Ledge						See under copper.
103	Globe	Glenn Hollis, Kelso	9	11N	14E	SB	West slope of Providence Mts. Quartz vein in granitic gneiss contains gold, silver, galena, and pyrite; strikes west, dips 65° S. Active as early as 1913. Developed by 1000-ft. adit. Idle. (Tucker 30:236; 31:296.)
104	Gloria Dee	W.F. Spaulding, Box 771, Route 1, Fontana	29	2N	3E	SB	Eastern San Bernardino Mts. Gold-bearing gravel at junction of small creek and Rattlesnake Canyon. Site of former arrastres. No production.
	Gold Bar						See Vanderbilt.
	Gold Basin						See True Blue.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
105	Gold Belt (Gold Peak, Mc-Ginnis)	E.L. Mellville Estate and others, Chula Vista (1940)	30,31	7N	1E	SB	West Ord Mts. northeast of Victorville. Free gold associated with pyrite and chalcopyrite in a quartz- and calcite-filled vein in granitic rock; strike N. 40° E. dip 45° SE. Vein developed through a 275-ft. vertical range by a shaft with level workings at 50, 100 and 240 ft. and an 820-ft. haulage adit connecting with shaft. Levels also connected by a 270-ft. raise to surface from haulage adit and by other intermediate raises. A 40-ton mill operated 1930-32, now removed and mine idle. (Eric 48:306; Tucker 30:236; 31:296-297; 40:235-236; 43:448-449, pl. 7.)
106	Gold Bronze	W.L. Marsh, Ivanpah (1940)	2	14N	16E	SB	Vanderbilt district. Two parallel gold-bearing quartz veins, about 200 feet apart in Archean granitic gneiss. Veins strike west, dip 70° N., average 6 ft. wide. North vein followed by 300-ft. inclined shaft; south vein by 200-ft. inclined shaft. Ore obtained mostly from oxidized part of vein above 100-ft. level. Said to have averaged $20 per ton in gold. Worked intermittently since early 1890's. Last operated 1940. (Crawford 94:232; 96:321; Storms 93:367; Tucker 30:236; 31:297.)
	Gold Bullion	J.F. Tedford, Oro Grande (1931)	10	6N	4W	SB	Oro Grande district. Adjoins Ozark on the south. Quartz vein, 2 to 3 ft. wide, strike N. 10° E., dip 85° W.; in Sidewinder andesite. Developed by nearly vertical 80-ft. shaft. Idle. (Tucker 30:237; 31:297.)
107	Gold Chief	Gold Chief Mines, Inc., J. Ralph McInerny, 1639 W. 45th St., Los Angeles	18	13N	16E	SB	South end New York Mts. Two gold-bearing, quartose zones in Archean metamorphic complex. Zones strike north, dip steeply west. Explored 1895-1915; sampling in 1915 said to show 40,000 tons valued at $8.35 per ton (1915 price). Inclined shaft 200 ft. long, with levels at 80, 100, and 200 ft.; about 800 ft. of drifts and cross-cuts, mainly south of shaft. Small production in 1904; idle since.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Gold Crown						See Supply. Gold Crown Mining Co. operated Supply and Nightingale mines 1930 to 1942. Produced over $500,000 in gold. (Tucker 40:12, 62-65; 43:449-451, pl. 7.)
	Gold Crown group						See Merrick.
	Gold Divide						See under tungsten. (Tucker 40:65-66; 43:451, pl. 7.)
108	Gold Hammer	Ray Emery, 5916 Cerritos Ave., Long Beach	14	8N	15E	SB	Northeast end Clipper Mts. Series of narrow quartz veins strike N. dip 5° - 10° E. Numerous open pits and 60 ft. shaft inclined 30° N. in a direction N. 55° W. plus 180-ft. inclined shaft.
109	Gold Hill	Jim Stocker, Big Bear City	17	2N	2E	SB	In San Bernardino Mts. south of Baldwin Lake. Series of parallel, gold-bearing veins along bedding planes in Saragossa quartzite; near contact with quartz monzonite. Ore said to be low grade. Workings mainly on 2 claims. Crosscut adit 1200 ft. long with 200-ft. drift. Several short shafts, cuts, and adits. May have yielded small tonnage gold ore. (Eric 48:306; Tucker 40:66; 43:452, pl. 7.)
	Gold King	George Comas, 630 W. 4th St., Los Angeles	36	7N	4W	SB	Oro Grande district. Eastward-striking quartz veins in Sidewinder andesite. Veins 4 in. to 2 ft. wide, dip moderately to south, contain auriferous pyrite. North vein explored by 80 ft. inclined shaft and open cut 100 ft. along vein. South vein explored by inclined shaft and open cuts. A 350-ft. crosscut adit intersects both veins at a depth of 50 ft. Last active 1948-49. (Tucker 30:237; 31:297.)
	Gold Mountain						See Doble. (Crawford 94:232; 96:322; Tucker 21:346-347; 30:237; 31:298; 40:66-67; 43:452-453, pl. 7.)
	Gold Peak						See Gold Belt.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
110	Gold Peak	R.E. Johnson, Victorville (1940)	31	6N	3E	SB	In Fry Mts. northeast of Victorville. Four parallel veins in quartz monzonite, strike north, vertical dip, width 2 to 4 ft. Vein carries free gold associated with pyrite. Developed by 120-ft. vertical shaft with level workings at 50 and 100 ft. Ore was milled at Old Woman Springs in early 1900's. Production by Gold Peak Mining Co. reported over \$40,000 prior to 1914. Long idle. (Cloudman 19:810; Eric 48:306; Tucker 40:236.)
	Gold Pin						See Arrowhead. (Tucker 31:326-327.)
111	Gold Point (Henshaw, Murray)	Abba Gold Mining Corp., Max E. Socha, 738 Eighth St., San Bernardino	1	3N	1W	SB	San Bernardino Mts., north slope Silver Creek district. Gold-bearing quartz vein on contact of brecciated dolomite and granite. Strike NE., dip 35° SE., width 4 to 6 ft. Developed by 2 adits, 200 and 600 ft. long. Idle. (Eric 48:312; Tucker 30:245; 31:305-306; 43:453, pl. 7.)
112	Gold Reef (Consolidation for operating purposes during 1917-18, of the Clipper Mountain, Gold Reef and Tom Reed mines)	Gold Reef Consolidated Mining Co., S.S. Wold, pres., 600 I.W. Hellman Bldg., Los Angeles (1930)	14,15	7N	15E	SB	Southeast slope Clipper Mts. Gold Reef district discovered 1915. Large gold-bearing quartz-calcite veins crop out boldly in Miocene volcanic rocks; follow strong northwest-striking faults. Main reef max. width 50 ft., at least 1500 ft. long. Strong parallel veins crop out along this zone for a distance of 4 miles. Veins dip 60° SW. Clipper Mountain had workings from a 300-ft. vertical shaft; Tom Reed had a 500-ft. vertical shaft. Water, encountered in both, caused operating difficulties and cessation of activity. (Tucker 21:344,345,346; 30:237-238; 31:298; 43: pl. 7.)
113	Gold Ridge (Ibex)	Rene G. Anthony	13,24	9N	20E	SB	Northwest of Needles. Massive quartz vein crops out boldly; has easterly strike, northerly dip. Located in 1888. Gold ore said to be free milling and a 10-stamp mill was erected in 1894. Extensive workings are indicated by several caved shafts and open cuts along strike. Long idle.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
113	Gold Ridge (Ibex) (continued)						(Crawford 94:233; 96:323-324; Crossman 90:239; Storms 93:368.)
	Gold Rose	C.A. Foletta, Dale Holmes, San Bernardino (1943)					Described in San Bernardino Co. reports but recent information indicates mine is actually in Riverside Co. (Tucker 30:238; 31:298-299; 40:67; 43:453; pl. 7.)
	Gold Standard						Whipple Mts. Auriferous copper minerals in veins in gneiss. See under copper.
114	Gold Standard	Wm. Wheelock Estate and others, Ludlow (1940)	32	7N	8E	SB	Stedman district south of Ludlow. Gold associated with oxidized iron, copper and manganese minerals in fracture zone in rhyolite. Zone strikes northeast, dips northwest. Explored by a 70-ft. shaft inclined 30° and 2 vertical shafts, one 50 ft. east 100 ft. deep, and the other 150 ft. south, 110 ft. deep. Small production 1935-38. Idle. (Eric 48:306; Tucker 40:236.)
	Gold Trails						See under copper. Small gold production 1937-40.
115	Gold Zone	Charles Dunbar, Box 75, Parker Dam, and George Albrecht, Needles	17	2N	27E	SB	Near Parker Dam. Auriferous pyrite and chalcopyrite in vein which strikes N. 75° - 80° E., dips 50° N., follows fault zone in pre-Cambrian gneiss. Developed by 400-ft. adit driven N. 75° E., with a 90-ft. raise to surface 300 ft. from portal. From same point a 90-ft. winze with drift 200 ft. S. 75° W. Ore reported to assay $12. per ton in gold. Production undetermined. Idle.
116	Golden Cycle (Camp Castle, Castle, Great Gold Belt)	Pearl Rayburn, P.O. Box 27, Cadiz	26	7N	13E	SB	In Bristol Mts. Probably worked by Indians. Rediscovered by Great Gold Belt Mining Co. in 1907. Worked in 1911 and intermittently 1933-41. Small production. Vein in granitic rock. Developed by two 275-ft. shafts, 60 ft. apart, and connected on 100-ft. level and bottom. Idle. (Eric 48:301; Tucker 30:230; 31:290-291.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Golden Era						See Silver Basin. See also Gold Basin under tungsten. (Tucker 30:233; 31:293-294.)
	Golden Star						See Prosperity.
	Golden West						See Mountain Flat. (Tucker 43:pl. 7.)
117	Goldstone	Leroy A. Wilson, 1126 So. Dewey Ave., Los Angeles	22	1S	12E	SB proj.	Dale district between Carlyle and Supply. Oxidized quartz vein strikes north dips 85° W., width 1 to $4\frac{1}{2}$ ft. Developed by 200-ft. shaft. Gold produced 1939-1942. Idle since.
118	Goldstone	R.D. and Lee Redfield, Box 806, Barstow	19	14N	1E	SB	Goldstone district. Quartz vein in fault plane between shaly limestone and siliceous shales. Trends NW., dip 45° E., width 3 ft. Explored for 450 ft. by open cuts shallow inclined shafts and 300-ft. vertical shaft. Operated 1916-18, 1925 and 1941. Total production small. (Cloudman 19:805-807; Tucker 24:47; 30:238-239; 31:299; 43:pl. 7.)
119	Grandview	Garvan Mining and Reduction Co., W.G. Van Horn Estate, Los Angeles (1940)	10,11	6N	2E	SB	Southeast slope Ord Mt., south of Daggett. Free gold in silicified, brecciated rhyolite porphyry. Vein with 3000-ft. outcrop and average width of 8-ft. Development includes 150-ft. inclined shaft with 75 ft. of drifting on 40-ft. level and 150 ft. of drifts on 100-ft. level. Ore milled had average value of $8.90 per ton. Latest production 1934. (Tucker 30:239-240; 31:299; 40:237; 43:pl. 7.)
	Great Gold Belt						See Golden Cycle.
120	Green Gold	Charles Dunbar, Parker Dam, and George Albrecht, Needles	19	14N	18E	SB	South end of Castle Mts. Gold-bearing fracture zones in layered rhyolite. Main vein strikes N. 35° E., dips vertically; developed by 2 shafts about 50, and 100 ft. deep. Thirty-foot shaft on other vein nearby. Last active in 1939 when several hundred tons gold ore shipped.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Green Hornet	R.A. Lassiter, P.O. Box 5912, Los Angeles		4N	5E	SB proj.	West of Emerson Dry Lake, near Emerson mine. Gold ore 75 percent free-milling, in 5-ft. quartz vein in granitic rock. Vein traced along surface for 120 ft. Strike northeast, dip northwest. A prospect only. Millsite located, formerly used by Los Padre mine.
121	Green Lead	Glenn I. Campbell, 14332 Dickens St., Sherman Oaks	27	3N	1W	SB	North slope San Bernardino Mts. west of Holcomb Valley. Gold-bearing quartz vein. Property patented 1876. Idle since 1900. (Crawford 96:322.)
122	Greene	W.H. Hile, C.P. Hale, J. Ruoff, Nipton	10	17N	13E	SB	North Clark Mt. area. Auriferous pyrite in siliceous veins associated with rhyolite porphyry cutting granite gneiss and schist. Workings inaccessible. Production undetermined. Idle.
123	Hafford	James McDonald Manning Tuscon, Arizona (1943)	14,15 22,23	25S	45E	MD proj.	East slope Slate Range east of Trona. Gold-bearing vein on contact granite and schist, strike N. 30° W., dip 85° NE. Developed by 100-ft. vertical shaft with levels at 50 and 100 ft. Idle. (Tucker 43:453-454, pl. 7.)
	Hammerback and Patterson						See Barrett.
124	Harvey K (Hepburn)	M.E. and A.K. Hepburn, Box 5, Fawnskin	29	3N	1E	SB	Holcomb Valley area, San Bernardino Mts. Gold-bearing, locally-siliceous fracture zone in quartz monzonite. Inclined, 200-ft. shaft with short drifts. Probably opened in 1890's. Small tonnage gold ore shipped.
	Hecla						See Santa Fe. (Crossman 90:226; De Groot 90:524.)
	Henshaw						See Gold Point. (Tucker 30:245; 31:305-306.)
	Hepburn						See Harvey K.
	Hercules						See Scando.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
125	Hidden Hills	Hidden Hills Mining Co., Lee A. Otterson and Roger Wilbur, P.O. Box 641, Colusa	1 6	8N 8N	13E 14E	SB SB	Southeast end Providence Mts. Located 1882. Series of narrow, 1- to 12-inch quartz veins following brecciated fracture zones in granite. Veins strike N. 30° E. dip 45° NW. Noted for pockets of high-grade ore. One pocket, mined in 1915, said to consist of 300 pounds valued at $13,000. Golden Queen Claim yielded over $6,000 prior to 1907. Total production undetermined. Inclined shaft 240 ft. deep; a 350 ft. crosscut adit and numerous other workings more recent, but less extensive. Idle. (Cloudman 19:787,801; Crawford 96:323; Eric 48:307; Tucker 21:348; 30:213,240; 31:273,301; 43:pl. 7.)
	Hidden Treasure						See Ivanhoe.
	Hoganson	Hoganson Mining Co., N.A. Hoganson, pres., Culver City (1943)	14	6N	4W	SB	Oro Grande district. Steeply dipping, 4-ft. quartz veins in quartz monzonite. Explored by 125-ft. shaft with levels at 50 and 100 ft. Ore reported to carry $10 to $16 per ton in gold. Idle. (Tucker 43:454, pl. 7.)
126	Holliday	Roy A. Saviers, P.O. Box 3, Big Bear City	29	2N	3E	SB	San Bernardino Mts. east end. Gold- and tungsten-bearing oxidized zone in calcareous schist. Explored by 20-ft. trench about 15 ft. deep. No production.
127	Hollie-Ann	H.O. Rice, 6541 Specht Ave., Bell	29	2N	3E	SB	San Bernardino Mts. east end. Gold-and tungsten-bearing quartz veins in contorted quartz-biotite schist near granite contact. North-striking veins explored by shafts 20 and 80 ft. deep, and 100 ft. apart.
128	Holcomb Valley placers	Numerous holdings	29,31,32,33 4,5,6	3N 2N	1E 1E	SB SB	San Bernardino Mts., north of Big Bear Lake. Placers discovered 1860; extensively and profitably worked for a few years; intermittently worked since. Probably first large mining operation in county. Unsuccessfully developed by Holcomb Valley Co., Ltd., an English concern, in late 1880's and early 1890's. Worked as late as 1930's.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
128	Holcomb Valley placers (continued)						Sparsity of water a hindrance. Idle. (Cloudman 19:798-799; Crawford 94:235; 96:323; De Groot 94:523; Haley 23:154; Tucker 20:349; 30:241; 31:301; 32:254; 34:250.)
129	Hoover	Mrs. Souls, Barstow (1940)	10	6N	2E	SB	Southeast slope Ord. Mt. Narrow, steeply dipping quartz veins in meta-porphyry and a mineralized rhyolite dike 20 to 50 ft. wide. Explored by 90-ft. cross-cut adit driven north, with a 120-ft. drift, and 50-ft. shaft. Idle. (Tucker 40:237.)
	Ibex						See Gold Ridge. (Crawford 94:233; 96:323-324; Crossman 90:239; Storms 93:368.)
	Investment						See Big Horn. (Tucker 21:349; 24:196-198; 30:243; 31:303-304.)
130	Islander	A.J. Meadows, Parker Dam and Wm. B. Smith, Delano. Leased (1950) to Roy Bell, Parker Dam	4	3N	26E	SB	North slope Whipple Mts. near Lake Havasu. Gold and copper minerals in vein in pre-Cambrian metamorphic complex. Near contact with Tertiary volcanic rocks. Explored by 3 adits, totaling several hundred feet in length. Operated 1936-37, 1943-44 and 1949-50. Idle. (Eric 48:308.)
131	Ivanhoe (Hidden Treasure)	H.D. Smith, 1535 E. 16th St., Los Angeles	23,26	1S	12E	SB proj.	Dale District. Three parallel, steeply dipping veins in andesite porphyry. Principal workings on Ivanhoe vein; shaft 250 ft. deep, 4 levels with 2000 ft. of workings. Operated by lessee intermittently during the 1930's and 1940's and briefly during 1951. (Cloudman 19:802-803; Tucker 30:241-242; 31:302; 40:68; 43:454, pl. 7.)
132	Ivanhoe Mill	Harold D. Smith, 1535 E. 16th St., Los Angeles	1	1S	11E	SB proj.	At Old Dale. Small concentrating mill utilizing amalgamation and flotation. Constructed 1947 and operated intermittently on ore from Ivanhoe mine and on custom ores from the area. Idle.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Ivanpah	Various. Undetermined	24 (?)	17N	13E	SB	See under silver.
	Jackass						See Stewart.
	Jarvis						See Ethel Leona.
	Jean						Part of Supply mine. Jean vein parallel to Supply vein and about 1000 ft. east; strike north, dip 70° E. Developed by 250-ft. inclined shaft with over 1500 ft. of level workings. Lessees operated the Jean separately in 1940 and 1941 and produced a small tonnage of gold ore. (Tucker 30:254; 31:315.)
	Jeff Davis						See under lead-silver-zinc.
133	Jo Je (Midway)	E.M. Manny, 7108 Beverly Blvd., Los Angeles	23	11N	13E	SB proj.	Providence Mts. Gold-bearing quartz veins in quartz monzonite. Veins as much as 2 ft. thick. Inclined shaft 140 ft. deep, two levels with drifts totaling about 300 ft.; also 50-ft. vertical shaft. Worked intermittently since early 1900's, mostly in mid-1920's and early 1940's. Ore treated in small cyanide mill on property. Idle since 1944.
	Joburg Divide						See Pioneer. (Hulin 25:144.)
134	John Henry	J.H. Estlow, P.O. Box 182, Yucca Valley	28	2N	3E	SB	San Bernardino Mts. east end. Auriferous gravels in Rattlesnake Canyon.
135	Johnson	R.H. Johnson, Pasadena (1940)	36 31	6N 6N	2E 3E	SB SB	West slope of Fry Mts. southwest of Daggett. Iron-stained quartz in shear zone in gneissic diorite. Vein 1 to 4 ft. wide associated with diorite dike. Carries pyrite, arsenopyrite, and free gold. Workings include 400-ft. crosscut adit and 250 ft. of drifting each way along vein. Long

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
135	Johnson (continued)						idle. (Tucker 30:242; 31:302-303; 40:68.)
136	Jumbo	Strace Mining Co.	25	15N	9E	SB	East of Baker. Gold-bearing quartz vein 4 to 6 ft. wide in Archean schist and gneiss. Vein strikes N. 70° E., dips steeply south. Developed by 40 ft. shaft and short connecting adit.
	Jupiter	Selters Bush, Los Angeles	-	1S	12E	SB proj.	Dale district, between the Carlyle and Supply mines. Two gold-bearing veins 30 ft. apart in andesite porphyry; strike N. 14° E., dip 80° W. Principal development on the Jupiter vein. Adit driven south 200 ft. with several 100-ft. of workings. A 200-ft. shaft sunk on the vein south of the adit workings. Property operated in 1937 and production reported as 1000 tons of ore averaging $25 gold per ton. Idle. (Tucker 38:15; 40:68; 43:454, pl.7.)
	Kewanee	Harry Markel, deceased	33	15N	14E	SB	Ivanpah Mts. Gold-bearing vein, recemented quartz breccia, in granite and granite gneiss. Three shafts caved below 50 ft. Idle since 1906.
137	Keystone	James W. Graef, 5121 Sunset Blvd., Los Angeles and John Vader, 5463 Dahlia Ave., Eagle Rock	18	7N	2W	SB	South slope Stoddard Mts. Also possibly tungsten. (Jenkins 42:351; Kerr 46:165; Tucker 30:242; 31:303; herein.)
	King Tut	J.B. Tutton and Hal Hobaugh	2	6N	4W	SB	Silver Mt. district north of Victorville. Moderately dipping, irregular quartz stringer in Sidewinder volcanic rocks; contains auriferous pyrite. Explored by shallow inclined shaft sunk on the vein and by several open cuts. A prospect. Idle.
	Lady Alice						See Santa Fe. (Crossman 90:226.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Lady Lou						See under copper.
138	Lester	W.F. Dail, Lucerne Valley	21	3N	2E	SB proj.	North slope San Bernardino Mts., 4 mi. east of Blackhawk Canyon. Two quartz veins in granitic rock. Developed by several short tunnels and shallow shafts. Opened probably in late 1920's. Small cyanide mill on property. Small shipments in 1952. (Tucker 30:242; 31:303.)
	Livingstone						See Morongo King. (Crawford 94:231; 96:320.)
139	Log Cabin	Roy A. Saviers, P.O. Box 3, Big Bear City	29,30	2N	3E	SB	San Bernardino Mts. east end. Gold and scheelite in narrow tactite zone at mica-schist and granite contact. Explored by surface trenching only; no production. Pilot mill consisting of rolls, screen, jig and table on property.
140	Long Shot	L.J. Rouchleau, 2700 Budlong Ave., and Mrs. M.M. Richardson, Los Angeles	30,32	6N	17E	SB	Old Woman Mts. Steeply dipping quartz vein, 1 to 4 ft. wide, in granite. Outcrop length 6000 ft. contains auriferous pyrite and chalcopyrite. Developed by 70-ft. shaft, sunk on vein and connecting adit workings. Vein also cut by 300 ft. crosscut adit 160 ft. below upper adit. Ore mined reported to average $35 per ton. Operated 1940-42. Idle. (Eric 48:310; Tucker 40:69; 43:455, pl. 7.)
	Lookout						See Santa Fe. (Crawford 94:230; 96:324; De Groot 90:524.)
141	Los Padre	Los Padre Mining Co., M. C. Clemens, pres., 540 Title Ins. Bldg., Los Angeles (1943)	35	4N	5E	SB proj.	Near Emerson Dry Lake east of Lucerne Valley. Steeply dipping gold-bearing quartz vein in gneissoid granite; width 2 to 3 ft. A 150-ft. inclined shaft sunk on vein connects with a drift adit at 50 ft. and with a drift off a 700-ft. crosscut adit at 150 ft. Drifts on these levels have explored the vein for 380 ft. High grade ore recovered from upper workings; some gold in wire form. Ore treated in mill half a mile west of mine. Idle. (Tucker 40:70; 43:

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
141	Los Padre (continued)						455-456, pl. 7.)
	Louisiana - California						See Leiser Ray under vanadium.
142	Lucky	J.E. Stevenson, Los Angeles (1939)	11	12N	10E	SB	North slope of Old Dad Mt. Small gold mine active 1932-35. On limestone-granite contact. Shipped 1100 tons ore obtained from several shallow cuts and adits. Exploration tunnel 700 ft. long beneath other workings.
	Lucky Baldwin						See Doble. (De Groot 90:523; Tucker 40:66-67; 43:452-453.)
	Lucky Jim						See under silver.
	Luhrman						Probably same as Nightingale. See Supply.
	Lytle Creek placers	Various - undetermined		2N 2N	6W 7W	SB SB	Eastern end San Gabriel Mts. Gold placer operations extending from near mouth of Lytle Creek Canyon to near its headwater on the slopes of Mt. San Antonio. Worked in the late 1800's by hydraulicking, sluicing, and hand methods.
	Mabel						See Big Horn. (Tucker 21:349; 24:196-198; 30:243; 31:303-304.)
	Mable group						See Big Horn. (Cloudman 19:801.)
143	Mancha No. 2	K.L. Storrs, 3030½ 9th Ave., Los Angeles (1933)	19,30	14N	1E	SB	Goldstone. Quartz veins 1-2 ft. wide near contact of granite and schistose quartzite. Explored by 100-ft. (?) shaft and surface workings over several hundred yds. of exposed length. Idle.
144	Markeson	T.N. Hall, Ludlow (1940)	18	6N	8E	SB	South of Ludlow. Gold-bearing quartz vein along rhyolite-monzonite contact. Moderate dip, 4 to 6 ft. wide. Developed by open cuts and shafts. Main shaft inclined to depth of 110 ft. Ore shoot 60 ft. long, average width 5 ft.,

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
144	Markeson (continued)						mined between 100- and 40-ft. levels. Average value of ore $11.74 per ton. Idle. (Eric 48:311; Tucker 40:238.)
	McClintock						See Vulcan.
145	McClure-Bess	Charles V. McClure, Box 16, Yucca Valley, and L.Z. Bess, 890 Campus Way, San Bernardino. Leased to Hanson Wheel Construction Co., 4763 Columbine St., Denver, Colorado	16	2N	3E	SB	East end San Bernardino Mts. Coarse placer gold in terrace and stream gravels. Gold valued at about $1,000 removed since 1941 in testing by dry-placer methods. Water supply developed in 1948. Idle in early 1952.
	McGinnis						See Gold Belt.
146	Merrick (Gold Crown group)	Mrs. Nora Merrick, Box 874, Barstow	20	14N	1E	SB	Goldstone district. Gold- and silver-bearing quartz seams in schist. Small production in 1936 and 1938-40. Idle since. (Tucker 40:70-71; 43:456, pl. 7.)
	Mescal						See Mollusk. (Crawford 96:61,324; Crossman 90:217.)
	Midnight	H.A. and F.H. Vice, Reseda	28	11N	2E	SB	North edge Calico Mts. south of Coyote Dry Lake. Two parallel quartz veins, 6 to 12 inches thick, in granitic rock. Quartz vuggy, iron-stained and gold-bearing. Grade decreases with depth. Explored by two 50-ft. shafts and a 6-ft. pit. Idle.
	Midway						See Jo Je.
	Mitchell						See Denver.
147	Mollusk (Cambria, Mescal)	Dr. Nowland MacFarlane, 5217 South Main, Los	24	16N	13E	SB proj.	In Mescal Range southeast of Mountain Pass. Also silver. (Cloudman 19:808; Crawford 96:61, 324; Crossman 90:217;

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
147	Mollusk (Cambria, Mescal) (continued)	Angeles					De Groot 90:531-532; Eric 48:301; herein.)
	Montana						See Reward.
148	Morning Star	J.B. Mighton, Cima (1943). Leased to E.P. Halliburton 1709 W. 8th St., Los Angeles	21,27 28,33	15N	14E	SB	Southwest slope Ivanpah Mts. Gold-bearing quartz veinlets along fractured contact zone between coarse-grained granitic rock and finer-grained, darker granitic rock. Explored by north-trending, 600-ft. drift adit, joined to winzes, cross-cuts and drifts totaling 1700 ft. In 1942 said to have developed 500,000 tons of gold ore valued at $7 per ton. Explored mainly in late 1920's and in 1930's. Little or no ore shipped. Idle since 1942. (Tucker 30:244; 31:304-305; 40:71; 43:456, pl. 7.)
	Morongo King (Center, Livingstone)			2N	3E	SB	See also Sunnyside under tungsten. Eastern San Bernardino Mts. Discovered 1887; worked by Morongo King Mining Co. 1887-1895. Quartz vein along granite-limestone contact. Free milling gold ore treated in 10-stamp mill on property. Mill removed in 1895. Tungsten discovered in 1941. (Cloudman 19:800; Crawford 94:231,234; 96:320,325; Crossman 90:227; De Groot 90:526; Eric 48:317; Irelan 88:504; Tucker 30:244-245; 31:305.)
149	Mountain Flat (Golden West)	T.F. Terry and H.G. Corson (1950)	35	12N	20E	SB	North end Dead Mts. Vuggy, iron-stained quartz vein in granite; trends northwest. Steeply dipping, 2 to 5 ft. wide. Explored 600-ft. along strike of shallow shafts and pits. Idle. (Tucker 43: pl. 7.)
	Murray						See Gold Point. (Eric 48:312; Tucker 30:245; 31:305.)
150	New Era	Ross Gill, Cima	20(?)	15N	14E	SB	Ivanpah Mts. southeast of Mountain Pass. (Herein.)
151	Nickel Plate	E.B. Trent, Blythe	8	2N	26E	SB	Whipple Mts., west side Monument Peak. Oxidized copper

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
151	Nickel Plate (continued)						minerals and gold in vein in pre-Cambrian metamorphic rocks. Explored by 300-ft. cross cut adit, driven N. 80° E., appended to short drifts, winzes, raises and stopes. Vein exposed 50 ft. above adit along open cut for less than 100-ft. Operated by lessees as late as 1941. Idle. (Eric 48:313.)
	Nightingale (Luhrman)						See Supply.
	Nightingale and Supply						See Supply. (Tucker 38:14.)
	Norman Fraction						See Pioneer.
152	O.K.	Charles Chamberlain, Johannesburg	31	29S	41E	MD	East of Johannesburg. Gold-bearing quartz veins in quartz monzonite. Developed by inclined 370-ft. shaft with levels at 240, 300, and 370 ft. Drifts and cross cuts total 475 ft. Opened 1939. Small output gold ore. Reserves said to average $12 per ton.
153	O.K. (Storm King Consolidated)	Seeley Mudd Estate, 523 W. 6th St., Los Angeles	35	1S	12E	SB proj.	Dale district. Free gold in steeply dipping quartz vein striking N. 20° E. along andesite porphyry-quartz monzonite contact. Vein explored to depth of 800 ft. by inclined shaft and extensive level workings. Mine first operated in 1900; production prior to 1915 reported to be over $200,000. Operated by lessees in 1941. Idle since. (Cloudman 19:802; Eric 48:313; Tucker 30:246; 31:306.)
154	Old Pete (Yim-Wheelock)	Lee Yim and William Wheelock Estate, Ludlow	33	7N	8E	SB	Stedman district south of Ludlow. Discovered in 1932. Specular hematite with free gold in brecciated dacite porphyry along contact with quartz monzonite. Developed by open cut 50 ft. long, 30 ft. wide and 40 ft. deep; 100 ft. adit driven west from cut. Ten ft. below cut, 60 ft. adit driven south. Reported output of $30,000 from ore averaging 0.81 oz. of gold per ton. Idle since 1940. (Er-

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
154	Old Pete (Yim-Wheelock) (continued)						ic 48:313; Tucker 34:310,325,326; 40:240; 43:456-457, pl. 7.)
155	Olympus (Paradise)	Olympus Gold Mining Co., San Bernardino. Lessee (1940-41): Fred Matthis Barstow	24	12N	1E	SB	South end Paradise Range. (Newman 23:613; Tucker 21:350; 24:48; 30:246; 31:306-307; herein.)
	Opera						See Santa Fe (Crawford 96:326.)
	Orange Blossom (Gold Coin, Orange Blossom Extension)						See under copper.
	Orange Blossom Extension						See Orange Blossom under copper.
156	Ord Belt	W.A. Raymond, Upland	10	6N	2E	SB	South end Ord Mt., south of Daggett. Gold-bearing quartz veins, 5 ft. max. width, cut monzonite, rhyolite and dacite. Development includes 6 adits from 75 to 500 ft. long totaling about 1300 ft. Long idle. (Tucker 30:247; 31:307-308; 40:238-239; 43: pl. 7.)
	Ord Mountain						West flank Ord Mt. Copper mine first worked for gold. Rich, oxidized from near surface, treated in arrastres. Production from Rio Vista claim over $10,000, probably prior to 1900. See under copper.
157	Oro Belle	W.W. Hartman, 1230 E. 109th St., Los Angeles	18, 19	14N	18E	SB	West slope Castle Mts. Gold-bearing zones along fractures in Tertiary rhyolite. Main vein strikes NE., dips 60° SE. Cut by 400 ft. northwest-trending crosscut. Followed by 400-ft. drift to NE. and 45 ft. drift to SW. Stoped for 300 ft. to NE. Vertical shaft, 700 ft. deep (owner's report), NE. of adit portal. Most of development work done about 1915-20. Ore shipped (3000 to 4000 tons, avg. $12 per ton in gold) only in early 1940's. Milled at nearby

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
157	Oro Belle (continued)						Valley View mine.
158	Oro Fino	Jerry Korfist, Baker	23,26	13N	10E	SB	North of Old Dad Mt. (Tucker 31:329; 43:457, pl. 7; herein.)
159	Oro Grande	E.A. Powell, Victorville (1941)	17(?)	6N	4W	SB	Northeast of Oro Grande. Silicified zone in schist; carries free gold and auriferous pyrite. First worked prior to 1890 by the Oro Grande Mining & Milling Co.; ore mined from 250-ft. shaft treated in the company's 10-stamp custom mill. Workings consist of open cut 200 ft. long and 20 ft. max. depth along silicified zone; shaft in bottom of cut, inaccessible. Last worked 1939-1941. (Cloudman 19:814; Crawford 96:326; Crossman 90:227; Eric 48:313; Tucker 30:247-248; 31:308.)
	Oro Plata						See Cerro de la Plata under lead-silver-zinc.
160	Osborne	W.A. Franklin estate, Los Angeles	33	3N	1E	SB	Holcomb Valley area, San Bernardino Mts. (De Groot 90:523; herein.)
161	Ozark	R.R. Garrison, Oro Grande (1935)	3	6N	4W	SB	Oro Grande district. Free gold and auriferous pyrite in stockwork of quartz stringers in Sidewinder andesite. Developed by 90-ft. shaft with short level workings at 50 and 90 ft. Idle since 1934-35. (Cloudman 19:813-814; Eric 48:314; Tucker 30:218,248; 31:278,309.)
162	Ozier mine	August Voght and Walter Alf, Daggett	20	3N	1E	SB	North of Holcomb Valley, San Bernardino Mts. (Herein.)
	Pacific Mines						See Bagdad Chase. (Cloudman 19:790; Gardner 40:261, 275; Tucker 21:341-342; 30:218-219; 31:278-279.)
163	Pacific Coast Mill and Mining Company	Hoffman Estate, Herbert H. Hoffman, 11686 Dorn-	1	9N	2W	SB	In west Barstow. Also copper. (Tucker 34:322-323; herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
163	Pacific Coast Mill and Mining Company (Barstow i Metals Extraction Co., (continued)	field Ave., San Fernando. Leased to Pacific Coast Mill and Mining Co., 1020 Highland Ave. National City					
164	Painsville	Mrs. I.D. Garringer, Los Angeles	24	7N	1E	SB	One of earliest locations in the Ord Mt. district; patented in 1890. Adjoins Rio Vista claim of the Ord Mountain copper mine on the south. Developed by open cut on top of 90-ft. shaft. Production probably small. Long idle. (Cloudman 19:808-809; De Groot 90:528-529; Eric 48:314; Tucker 30:249; 31:309-310; 40:239.)
	Paradise						See Olympus.
165	Parker group	L. Kenneth Parker, Box 18, Yucca Valley	14,15	2N	3E	SB	San Bernardino Mts., east end. Gold-bearing stream and terrace gravels tested by dry placer methods. Owner reports average value of $1 per yard. Idle.
166	Paymaster (Whitney)	Lawrence Z. Bess, 890 Campus Way, San Bernardino and Walter Thompson and associates, 1010 Cadberry Rd., Whittier. Leased to Jess and John F. Herrod, 222 So. Walnut, Brea.	22,23	13N	10E	SB	Northwest end Old Dad Mt. (Eric 48:314; Tucker 31:329-331; herein.)
	Pilot (B. and B.)	A.W. Eaton, Goffs (1916		9N	14E	SB	Providence Mts. adjoins Bliss Providence gold mine on the north. Has been incorrectly cross-referenced to the Frisco gold mine. A gold prospect. Long idle. (Cloudman 19:828; Eric 48:314. Other references to Pilot not applicable.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
167	Pioneer (Joburg Divide, Norman Fraction)	Undetermined	31	29S	41E	MD	Randsburg district. Gold-bearing veins in quartz monzonite. Vertical shaft, 257 ft. deep, with several 100 ft. of drifts. Active intermittently since mid-1930's. Worked in 1952. Small production. (Eric 48:314; Hulin 25:144.)
	Piute						See under lead-silver-zinc. (Eric 48:314.)
168	Prosperity (Golden Star)	Charles H. Brown, Needles (1943)	23	3N	21E	SB proj.	Northeast end Turtle Mts. Free gold with pyrite and chalcopyrite in 3 parallel quartz veins in granite. Developed by 2 shafts 3000 ft. apart, 100 and 150 ft. deep. Short drifts on 50-ft. level, 100 ft. shaft. Ore treated in small amalgamation plant. Idle. (Tucker 40:72; 43:457-458; pl.7.)
	Providence						See Bliss Providence. (Cloudman 19:827.)
169	Ramsey (Wheeler)	Ramsey Mining Co., Milton G. Ramsey, pres.	2,3	3N	2W	SB	San Bernardino Mts. north of Big Bear Lake. Quartz veins with pyrite and chalcopyrite associated with diorite dikes in granite; reported to carry \$20 to \$50 in gold per ton. Developed by inclined shaft, several adits and several thousand ft. of appended workings. Twenty-five-ton cyanide plant now dismantled. Last worked 1937-42 when 3000 tons of ore produced. (Eric 48:315; Tucker 40:72-73; 43:458-459, pl. 7.)
170	Rattlesnake Canyon placers	Wm. Schmidt, Box 611, Yucca Valley and R.E. Holder	27,28	2M	3E	SB	Eastern San Bernardino Mts. Gold placers intermittently worked; being developed in 1951.
	Red Bridg						See Victor. (Cloudman 19:807-809.)
	Red Bridge						See Victor. (Eric 48:315; Tucker 30:249-250; 31:310.)
171	Red Hills	William A. Raymond,	8	6N	3E	SB	North end Fry Mts. Erratically distributed gold in vuggy

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
171	Red Hills (continued)	Uplands					quartz vein along rhyolite dike cutting monzonite. Explored by 2 shallow shafts 2000 ft. apart and a 200-ft. adit. Idle since 1945. (Tucker 40:240; 43:pl. 7.)
172	Reward (Montana)	John E. Fry and Erma Cutler, Barstow	2,3 10,11	13N	1E	SB	Five miles southeast of Goldstone. Quartz vein in schist, width 2 to 6 ft., explored by 600 ft. drift adit. An ore shoot, 150 ft. long, 4 ft. average width, developed and mined to the surface. Ore treated in 20-ton amalgamation mill on property; reported to have averaged $30 per ton in gold. Lenses of copper ore discovered 570 ft. from adit portal and explored by 112 ft. winze. Last worked 1937 and 1940. (Tucker 38:15; 40:73-74; 43:459, pl. 7.)
173	Rex	Tom Clark, J.C. Donnelly; C.C. Adams, Kelso	10	10N	13E	SB	West-central Providence Mts. Gold-bearing shear zones in schist and granitic gneiss (both Archean). Developed zone is 4 to 12 ft. wide, strikes north and dips vertically to steeply west. Two vertical shafts, 30 and 60 ft. deep, and 300 ft. drift. Small shipments in 1934 and 1948. Small mill on property. Being developed 1952.
174	Rio Hondo	Vernon W. Joy and Dr. R.H. Chapin, Barstow; Bernice G. Bailey, Portland, Oregon	12	13N	1E	SB	Northeast of Barstow. (Tucker 40:74; 43:459, pl. 7; herein.)
	Riverview						See Ethel Leona. (Eric 48:315; Tucker 43:436, pl. 7.)
	Roosevelt Consolidated						See Bagdad Chase. (Cloudman 19:815.)
175	Rose (includes Christie workings)	Dell Swarthout, San Bernardino (1937)	19,20	2N	3E	SB	Eastern San Bernardino Mts. (Aubury 02:252; 08:334; Cloudman 19:790,795-796; Crawford 94:231,234-235; 96:324; Crossman 90:226-227; Eric 48:316; Tucker 30:250; 31:311; Vaughan 22:410-411; herein.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
176	Roulette	Roulette Mining Co., John P. Fleming, pres., R.R. 1, Hemet	6 31	3N 4N	26E 26E	SB proj. SB proj.	North of Whipple Mts. near Havasu Lake. Free gold and auriferous sulfides in parallel quartz veins in pre-Cambrian metamorphic rocks and Tertiary rhyolite. Roulette vein explored by 2 short drift adits, 50 ft. vertical interval. Other veins explored by shallow shafts and open cuts. Ore treated in 40-ton amalgamation and flotation mill. Operated 1935-37 and 1940-41. About 700 tons ore milled, averaged $8 per ton. (Tucker 43:459-460, pl. 7.)
	Roy Ex						See under tungsten.
177	St. Elmo	Undetermined	29,30	30S	41E	MD	South of Atolia. Two gold-bearing quartz veins in quartz monzonite, trend northeast, dip steeply; 4 to 10 ft. wide. Worked mainly by 2 vertical shafts, 250 and 150 ft. deep, with several thousand ft. of drifts and cross cuts. Gold mostly in high-grade pockets. Discovered 1895; most active late 1800's, but worked as recently as 1940-41. Said to have yielded nearly $250,000 gold. Idle. (Hulin 25:144; Lemmon 40:243; Tucker 30:253; 31:314.)
	Santa Fe						Prospect in Oro Grande district. (Crawford 96:34.)
178	Santa Fe (Includes workings known variously as Arlington, Black Hawk, Calle de Oro, Calumet, Cliff, Hecla, Lady Alice, Lookout, and Opera)	James Hay Estate, Los Angeles	5,8 9,16 17	3N	2E	SB	Northeast slope San Bernardino Mts. (Bailey 02:6; Cloudman 19:797-799; Crawford 94:230; 96:34,320,327; Crossman 90:226; De Groot 90:523-525; Eric 48:316; Newman 23:742; 23:30; Storms 93:364-365; Tucker 30:222-226; 31:282-286; 40:74-78; 43:440,460-461, pl. 7; Woodford 28:265-304; herein.)
	Savahai						Probably now part of Vidal Gold. First operated in 1911. One of earliest mines in the district. Small production. (Eric 48:316; Tucker 43: pl. 7.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
179	Scando (Hercules)	Robert E. Cram, Box 21 Searchlight, Nevada	26(?)	12N	17E	SB	North of Goffs. Quartz vein in Archean gneiss near contact with Miocene volcanic rocks. Developed by 2 shallow inclined shafts 10 feet apart. Idle.
	Sharp's Diggings						See Amargosa Gold Placers.
180	Sheep Hole	Harold Mills	27	2N	12E	SB proj.	Center of Sheep Hole Mts. Two parallel quartz veins in granite, 2 to 4 ft. wide, strike N. 35° - 40° W., dip 55° - 65° NE. Developed by inclined shaft and open cut. Old mill site with arrastra on property. Idle.
181	Sidewinder	E.M. Nixon, 204 S. San Juan St., Loma Linda, and E.W. Tucker, 3985 Walnut St., Riverside	4,5	6N	2W	SB	Northeast of Victorville. (Crawford 94:235; 96:328; Crossman 90:227; De Groot 90:527-528; Tucker 30:252; 31:312-313; herein.)
182	Silver Basin (Elkhorn Mining Co., Golden Era)	Gold Basin Mines, Clarence Barker, Los Angeles (1943)	7	30S	41E	MD	Randsburg area. See Gold Basin under tungsten. Two gold-bearing iron-stained quartz veins in Rand schist. Veins 1 to 3 ft. wide, strike northwest, dip steeply northeast. Two shafts, one 240 ft. deep and the other more than 100 ft. deep, with 850 or more ft. of drifts. Highgrade gold ore mined near surface. Active 1920's and 1930's. (Hulin 25:141; Tucker 23:63, 169, 30:233; 31:293.)
	Silver Dome	Silver Dome Mining Co., A. Rolling, pres., Los Angeles (1930)	3	32S	42E	MD	Northwest of Harper Dry Lake. Four parallel veins in granite northeast of Silver Dome limestone deposit. Veins carry gold and silver associated with chalcopyrite pyrite and bornite. Developed by 450-ft. shaft. Level workings at 150 and 265 ft. have explored vein for maximum length of 165 ft. Long idle. (Eric 48:316; Tucker 23:172-173; 30:220, 253; 31:279,313-314.)
183	Sky Blue No. 3	V.W. Jay, et al, Box 195, Victorville	19	14N	1E	SB	Goldstone area. Irregular siliceous veins through fault zone in shattered siliceous shale and sericitic quartzite

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
183	Sky Blue No. 3 (continued)						Worked by inclined shaft, more than 100 ft. deep, and by several shallow pits. Long idle.
184	Smith	E.R. Smith, Ludlow (1941)	15	11N	6E	SB	South of Cave Mt. Small gold mine said to have yielded several thousand dollars worth of ore prior to 1923. Last active 1940. (Newman 23:64.)
185	Spangler	S.J. Spangler and D.R. Spangler, Johannesburg (1939)	36	27S	41E	MD	Northeast of Johannesburg.. Gold-bearing quartz vein in granitic rock. Strikes westward, dips 50° S. Developed by 2000 or more feet of shafts, adits, tunnels and winzes. Small tonnage ore shipped, averaged $40 per ton (operator's report). Work intermittent since 1896.
186	Star	B.G. Thompson, Kelso	8,9	11N	14E	SB	West slope Providence Mts. Siliceous gold- and copper-bearing veins in Archean schist and gneiss. Several short tunnels and shallow adits. Shipped small tonnage gold ore 1914-1915.
187	Stewart (Jackass)	Cecil Riding, Indio	16	2N	3E	SB	San Bernardino Mts., east end. Gold-bearing alaskite dikes and contact zone between mica schist and granite. Explored by adit reported to be 150 ft. long, now inaccessible. Idle for about 10 years.
	Storm King Consolidated						See O.K.
188	Sullivan No. 1 (Anaconda)	E.M. Reimiller, Twentynine Palms	22,27	1S	9E	SB	Twentynine Palms district. Gold ore in quartz vein striking N. 40° W., dipping 73° NE. Developed by 2 shafts 100 and 212 ft. deep. Production small. Idle. (Newman 23:265; Tucker 21:344-345; 30:222; 31:281.)
189	Sulphide Queen	Molybdenum Corp. of America, Los Angeles office, 3050 E. Slauson	12,13	16N	13E	SB	Southeast slope Clark Mt. Gold-silver-lead minerals in quartz vein at contact between aplite dike and Archean granitic gneiss. Vein strikes northwest dips steeply northeast; developed by inclined 365-ft. shaft with 4

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
189	Sulphide Queen (continued)						levels comprising about 2000 ft. of drifts and cross-cuts. Active in 1940's. Claims include Mountain Pass rare earth deposit discovered in 1950. See Mountain Pass mine in section on rare-earths. (Tucker 40:78-79; 43:461-462, pl. 7.)
190	Summit Diggings	Numerous holdings	1,12	29S	40E	MD	North of Johannesburg. Gold placers mainly in Kern Co., perhaps partly in San Bernardino Co. Material from older alluvium redeposited in thicknesses of 2 to 10 ft. Assayed 35¢ to $1.00 of gold per cu. yd. Worked mostly by dry washing. Attempt to wet wash, using water pumped 6 mi. from Goler, unsuccessful. Worked intermittently since 1890's. (Haley 23:158-159; Hulin 25:148; Laizure 34:247; Sampson 32:250; Tucker 29:48; 32:276,328.)
	Sunnyside						See under tungsten. (Jenkins 42:352; Tucker 41:586; 43:507.)
191	Supply (Jean; the Nightingale and Supply mines were operated by the Gold Crown Mining Co., and sometimes referred to as the Gold Crown.)	I.W. McManaman, Twentynine Palms	21,22, 27,28	1S	12E	SB proj.	Principal mines in the Dale district. (Cloudman 19:802; Tucker 30:254-255; 31:314-315; 38:14; 40:12,63-65; 43:449-451, pl. 7; herein.)
192	Telegraph	James B. Nosser, Johannesburg	16,17 20	15N	11E	SB	Halloran Springs district northeast of Baker. (Tucker 31:322; 38:15-16; 40:79-80; 43:462-463, pl. 7. herein.)
	Tom Reed		15	7N	15E	SB	See Gold Reef. (Tucker 21:344,346; 43:pl. 7.)
	Top Nest	Lessee (1940): E.G. Johnson, Palm Springs	22	1S	12E	SB proj.	Dale district. Small gold mine active early 1940's. Adjoins Ivanhoe on northwest. Vein parallel to Ivanhoe. Developed by 4 adits 200 to 600 ft. in length. Idle. (Tucker 40:79; 43:463, pl. 7.)

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
193	True Blue (Gold Basin)	Fred Cram, Box 6, Ivanpah	22(?)	12N	17E	SB	North of Goffs. Narrow gold-bearing quartz stringers in Archean metamorphic rocks. Developed by several shafts; one shaft 100 ft. with 200-ft. drift at bottom. Single stamp mill on property. Owner reports Albert Cram, father, produced $40,000 from property in early 1890's. Latest production, 7 tons gold ore in 1936. Idle.
	Tuscarora						See Ethel Leona. (Cloudman 19:791; Tucker 30:220; 31:280)
194	Uncle Sam	L.V. Storrs, Los Angeles (1943) (deceased)	20,21 28,29	14N	1E	SB	Goldstone district adjoining Merrick and Belmont. Small tonnage gold ore produced in 1938 and 1939 from 110-ft. shaft with 500 ft. workings on 50 and 100 ft. levels. Idle since. (Tucker 40:80-81; 43:463, pl. 7.)
	United Greenwater Copper Co.						Operated O.K. and Supply mines in Dale district several years prior to 1915. Reported production, $250,000 prior to 1915, possibly as high as $350,000. See Supply. (Cloudman 19:802.)
195	Valley View	Mrs. John Couch, 1649 Mullender Ave., Puente	19	14N	18E	SB	Hart district. Gold-bearing alteration zones along fractures in Tertiary rhyolite. Zones 3 to 5 ft. wide, strike north, dip steeply west. Vertical shaft, 200-ft. deep, with 3 levels; workings total about 3000 ft. Worked at intervals 1913-1942. Ore milled at cyanide plant on property; dismantled 1951. (Tucker 43:464, pl. 7.)
196	Vanderbilt (Boomerang, Brick Consolidated, Gold Bar, Webster)	Allen G. Campbell estate, Leland P. Reeder, executor, 9416 Santa Monica Blvd., Beverly Hills	2,3	14N	16E	SB	Central New York Mts. (Cloudman 19:816; Crawford 94:235; 96:329; Newman 23:9; Storms 93:367; Tucker 30:255; 31:317; 34:325; 43:464, pl. 7; herein.)
197	Vaughn placer	Floyd Vaughn, 380 Highway 99, San Bernardino	15	2N	3E	SB	San Bernardino Mts., east end. Gold-bearing terrace gravels worked intermittently by small-scale dry placer meth-

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
197	Vaughn placer (continued)						ods. Small past production. Idle.
198	Victor (Big Four, Red Bridge)	R.D. and Lee Redfield, Box 806, Barstow	22 18,19	30S 14N	47E 1E	MD SB	Goldstone district. Quartz seams in schist carrying gold, silver, and lead. Yielded small tonnage of ore in 1916, 1938 and 1939. Mined through three shafts about $\frac{1}{4}$ mile apart. Idle. (Cloudman 19:807; Eric 48:299; Tucker 30: 249-250; 31:310; 40:57; 43:441, pl. 7.)
199	Vidal Gold (Dollar Bill, Savahai)	Stewart Brothers and A. J. Gardner, Vidal	14,15	2N	23E	SB proj.	Whipple Mts., southwest base Savahai Peak. Group of operations possibly consolidated under Savahai Gold Mining Co. and Dollar Bill Mining Co. Two veins, about 350 ft. apart, in pre-Cambrian gneiss. West vein, probably the Savahai, strikes about north dips 80° W. to vertical. Explored by cuts and 3 shafts for strike length of about 600 ft. Main shaft inclined 80° W. East vein, the Dollar Bill, strikes north, dips 70° - 75° W., explored by cuts and 3 shafts along strike for about 800 ft. Veins carry gold associated with hematite and oxidized copper minerals. Savahai mill, now largely dismantled, treated ore by cyanidation. Last operations apparently in early 1940's. Dollar Bill most active 1932-37. Total production small. (Eric 48:316; Tucker 43:pl.7.)
200	Virginia Dale	Harry Hess, Morongo Valley	20	1S	12E	SB proj.	Westernmost mine in Dale district. (Bailey 02:10; Cloudman 19:802-803; Crawford 96:314; Tucker 30:259-260; 31: 319-320; 43:pl. 7; herein.)
	Von Trigger						North of Goffs. See under copper which was principal metal recovered. The property was first located in 1858, probably for gold. Relocated in 1891 for copper. In 1913 a 160-ton mill was erected in unsuccessful effort to treat gold ore by cyanidation and the copper ore by electrolysis.

GOLD (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
201	Vulcan (McClintock)	Helen C. King, 1030 So. Magnolia St., Los Angeles (1943)	11	5N	15E	SB	Northwest slope Ship Mts., southeast of Siam. Two parallel, steeply dipping veins. One, mined mostly for gold, cuts quartz diorite; other, mined mostly for copper, along limestone-quartz diorite contact. Developed by 2 shafts, 150 ft. apart. North shaft 500 ft. deep. Most development from south shaft, 175 ft. deep, with levels at 50,100,150 and 175 ft. Shafts connected on 50 and 150-ft. levels. Considerable ore stoped on both veins from level workings which explore veins for length of 435 ft. Property located 1898. Principal activity 1935-37 and 1941-42. Production nearly $80,000. (Eric 48:319; Tucker 43:137-138; 43:465, pl. 7.)
202	Wanderer (Wonderer)	M.A. Griffiths and A.C. Le Brun, 4060 Beverly Blvd., Los Angeles	8	15N	10E	SB	Near Halloran Springs. Gold-bearing quartz vein, 2 to 3 ft. wide, in quartz monzonite; strikes northeast, dips steeply southeast. Explored along strike for 2000 ft. by shallow shafts, cuts, and one 180-ft. shaft. Active in mid-1930's. Exploration work in 1951. (Tucker 31:320-321.)
203	Weaver Diggings	W.H. and W.E. Schmidt, Box 611, Yucca Valley	34	2N	3E	SB	East end San Bernardino Mts. Terrace gravel bearing gold and scheelite.
	Webster						See Vanderbilt. (Crawford 96:329.)
	Whatnot						See Four Brothers in this section and under tungsten. (Cloudman 19:815; Crawford 96:329; Crossman 90:228.)
	Wheeler						See Ramsey.
	Whitney						See Paymaster.
204	Williams Well placers	Jasper E. Dodson and others, General Delivery, Barstow	19,20, 29,30	32S	47E	MD	Twelve miles south of Goldstone. Sporadic dry placering for fine gold dispersed over wide area in decomposed granite. (Tucker 43:pl. 7; herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Wonderer						See Wanderer.
205	Wright	Alvin Linder, Box 264, Lucerne Valley	16,17	3N	1W	SB	San Bernardino Mts., north of Big Bear Lake. Two adits driven southwest and southeast along quartz veins in schistose quartz diorite. Production undetermined, but idle for years. A 5-stamp mill on property long abandoned.
	Yim-Wheelock						See Old Pete. (Tucker 34:325-326; 40:240.)

IRON

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Alarm		NE$\frac{1}{4}$ 1	5N	4E	SB	In Galway Dry Lake area. See New Bessemer. (Aubury 06:299; Bailey 02:13.)
206	Altuda (Globerson)	Nathan Globerson, 723 S. Fremont, Alhambra, and Robert Gold, Los Angeles	1	7N	3W	SB	(Tucker 43:469, pl. 7; herein.)
207	Amboy Iron	Conn Pulos, Amboy	18	6N	12E	SB	(Herein.)
	Armstrong and Doran						See Iron Hat. (Hamilton 22:46.)
	Arrowhead Lode						See Cave Mountain.
208	Ball	O.H. Ball, 2024 W. 62nd St., Los Angeles	3,4	6N	2W	SB	(Herein.)
	Basin						See Cave Canyon.
	Baxter						See Cave Canyon.
209	Beck (Iron Gossam. Kingston Mountains, Kingston Range)	Dorsey E. McLaughlin Estate, 1911 Mills Tower Bldg., San Francisco	32,33	20N	10E	SB proj.	(Aubury 06:300; Burchard 48:221-224; Crossman 90:236; Hewett 36:78; 48:193-206; Hodge 35, v.1:41; v. 3, ap. E-5:10-11; Powell 48:3, tbl. 2; Tucker 30:262; 31:335; 43:470, pl. 7; herein.)
210	Bessemer (Bessemer and Western, Iron Mountain, Western)	Bessemer Mines, Inc., Santa Ana	27, 28	6N	4E	SB	(Aubury 06:299-300; Bailey 02:13; Burchard 48:220; Cloudman 19:819; Crossman 90:235-236; Hewett 36:79; Hodge 35, v.1:41; v.3, ap.E-5:11; Johnson 48:234,235,237-239; Lamey 48:27-38; Powell 48:2-3, tbl.2; Tucker 30:262; 31:335; 40:241; 43:66-67,467,pl.7; Wiebelt 47:2-5; herein.)
	Bessemer and Western						See Bessemer. (Tucker 43:66-67; 43:467, pl.7.)

IRON (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
211	Bessemer Iron Mine No. 1	Southwestern Ore Company, 617 W. 7th St., Los Angeles	36	6N	4E	SB	In Galway Dry Lake area. Limonite gossan along fault zone in granite. No production. (Lamey 48:29,30,32,35, 38.)
	Bicycle Lake						See Tiefort Mountains.
212	Black Jack	J.W. Gray, Ludlow (1944)	24	6N	12E	SB	Near Amboy. (Tucker 43:127,468, pl. 7; herein.)
	Black Magic (Emma, Owl Hole)	Harold W. Orwig Estate, Los Angeles	9	18N	3E	SB proj.	Southeastern part of Owlshead Mts. Part of Black Magic manganese, which see. Hematite replacements in limestone near intrusive granite extend over 600 ft. length. Prospected by 180 ft. of open cuts. Samples reportedly indicate 50 percent iron, nearly 15 percent silica. (Hodge 35, v.1:40; v. 3, ap. E-5:10; Tucker 43:pl.7.)
213	Cave Canyon (Basin, Baxter)	California Portland Cement Co., 601 W. 5th St Los Angeles	11,12	11N	6E	SB	South of Cave Mt. (Aubury 06:299; Bailey 02:13; Boalich 23:112; Burchard 48:220; Cloudman 19:818; Hewett 36:78; Hodge 35, v.1, d:44; v.3, ap. E-5:14; Jones 16:308; Lamey 48:69-83; Leith 06:198; Lyon 14:40; Powell 48:3-4, tbl. 2; Thompson 29:32,509; Tucker 30:261; 31:333-334; 43:468, pl. 7; herein.)
214	Cave Mountain (Arrowhead Lode, Meir)	Frank Thomas, California Hotel, San Bernardino	20	12N	6E	SB	Small bodies of magnetite. Small smelter for pig iron production erected in 1948 by Frank Fawver near Afton. Smelter never operated. (Hewett 36:78; Tucker 43:469, pl. 7.)
215	Copper World	Arthur C. Becker, 8724 Dalton Ave., Los Angeles	23	2N	11E	SB proj.	(Tucker 43:469, pl. 7; herein.)
	Cornfield Spring	Undetermined		10N	14E	SB	Providence Mts. Specular hematite 3 miles NE. of Vulcan. Orebody cut by 600-ft. adit at depth of 175 ft. Indica-

IRON (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Cornfield Spring (continued)						ted reserves several hundred thousand tons, 60 percent iron. (Hewett 36:79; Hodge 35, v.1:40; v. 3 ap. E-5:10.)
	Dorris May (Iron Age Extension)	James Hill, Twentynine Palms	19	1S	13E	SB proj.	In Pinto Mts. Probably same as Iron Age Extension. See Eaton under gold. Magnetite and hematite in andesite near monzonite contact. Two adits driven on gold prospect. (Tucker 43:469, pl. 7.)
216	Ebony	Julius Holme, P.O. Box 28-C, Victorville. Leased to Dallas E. Walters.	15	6N	4E	SB	In Lava Bed district. Discontinuous bodies of magnetite and hematite in area 500 ft. long, 20-30 ft. wide. Contact metamorphic deposit in dolomite near syenite. Estimated reserves 100,000 tons, 40-50 percent iron. Prospected by 5 open cuts. (Lamey 48:28-32, 34-35, 38.)
	Emma						See Black Magic.
	Garlic Spring	Undetermined	11 (?)	12N	3E	SB	In Alvord Mt. area. Magnetite deposit 35 miles N. of Barstow. (Hodge 35, v.1:40; v.3,ap.E-5:10.)
	Globerson						See Altuda.(Tucker 43:469, pl.7.)
217	Iron Age	D. Rhea Igo Estate, Maude Igo, Mill Creek Canyon, Mentone; Marcus Pluth Estate and Carrie and R.H. Sayers. Leased to Ferro Co., 135 135 San Vincente Blvd., Santa Monica.	20, 29	1S	13E	SB proj.	In Pinto Mts. (Aubury 06:299; Bailey 02:13; Boalich 23:112; Burchard 48:211,213; Cloudman 19:818-819; Harder 10:228-239; Hewett 36:79; Hodge 35, v.1:40; v.3, ap.E-5:10; Thompson 29:32; Tucker 30:261; 31:334; 43:469, pl. 7; herein.)
	Iron Age Extension						See Dorris May.
	Iron Gossam						See Beck.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Iron Hand	Robert McCanley and assoc. (1943)		Approx. 12N	12E	SB	Near summit of Solo Mountain about 23 miles southeast of Baker. Discontinuous bodies of magnetite and hematite in limestone near monzonite intrusive.
218	Iron Hat (Armstrong and Doran, Ironclad)	Arthur L. Doran, Barstow. Leased to Riverside Cement Co., 621 So. Hope St., Los Angeles.	17, 18, 19, 20, 21	6N	14E	SB	In Marble Mts. (Burchard 48:220; Hewett 36:79; Hodge 35, v.1:40; v.3,ap.E-5:10; Lamey 48:99-109; Powell 48:4, tbl. 2; Thompson 29:32,691; Tucker 30:261-262; 31:334; 43:470, pl. 7; herein.)
219	Iron King (Silver Lake)	Kaiser Steel Corp., Fontana	18, 19	15N	7E	SB	South of Avawatz Range. (Bailey 02:13; Burchard 48:220, 221,224; Lamey 48:41-58; herein.)
220	Iron Mountain (Silver Lake)	Kaiser Steel Corp., Fontana	11, 12, 13, 14	15N	6E	SB	South of Avawatz Range. (Aubury 06:299; Bailey 02:13; Boalich 23:112; Burchard 48:220,221, 224; Cloudman 19:820; Crossman 90:299; Hewett 36:78; Hodge 35, v.1:42,43; v.3,ap.E-5:12; Johnson 48:234,235,237;Jones 15:1899; Julihn 45:7-10; Lamey 48:41-58; Lyon 14:40; Powell 48:3, tbl.2; Thompson 29:32,596; Tucker 30:262; 31:335; 43:470, pl.7; U.S. Bur. Mines 45; herein.)
	Iron Mountain deposits		1,12 15, 27, 28, 36	5N 6N	4E 4E	SB SB	Northwest of Galway Dry Lake. See Bessemer, Bessemer Iron Mine No. 1, Ebony, Morris Lode and New Bessemer. (Aubury 06:299-300; Cloudman 19:819-820; Crawford 94:327; Crossman 90:235-236; Gardner 40:261; Hodge 35, v.1:41; v.3, ap.E-5:11; Julihn 45:7,10; Lamey 48:25-38; Lyon 14:40; Thompson 29:32,596; Tucker 30:262; 31:335; 43:470, pl. 7; Wiebelt 47.)
221	Iron Victory	Gustav A. Overstrom, 181 Palatine Dr., Alhambra. Leased by Desert Mines, Inc.	2	8N	12E	SB	In Granite Mts. Magnetite and hematite in contact metamorphic deposit. Owner reports outcrop 350 ft. long, 50 to 100 ft. wide and grade of ore 37.5 to 59.2 percent iron, low sulfur and phosphorus. Developed only by small open cuts.

IRON (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	LOCATION T.	LOCATION R.	LOCATION B & M	REMARKS
	Ironclad						See Iron Hat.
	Kingston Mountains						See Beck.
	Kingston Range deposits						In Kingston Range. See Beck. (Boalich 23:112; Crossman 90:236; Hewett 36:78; 48:193-206; Hodge 35, v.1:41; v. 3, ap.E-5:10-11; Powell 48:3, tbl. 2; Tucker 30:262; 31: 335; 43:470-471, pl.7.)
	Mammoth group	Mr. and Mrs. Harry Koenig, 1005 Locust Ave., Long Beach	27	32S	47E	MD	Lane Mts. area. No further information.
			19	12N	1E	SB	
	Meir						See Cave Mountain. (Hewett 36:78.)
222	Morris Lode (Van Buren group)	Kaiser Steel Corp., Fontana	12 7	5N 5N	4E 5E	SB SB	Near Galway Dry Lake. (Bailey 02:14; Lamey 48:27-28; Powell 48:2-3, tbl. 2; Tucker 43:471-473, pl. 7; Wiebelt 47; herein.)
223	New Bessemer (Alarm)	Mineral Materials Co., 1145 Westminister Ave., Alhambra	1	5N	4E	SB	Galway Dry Lake area. Small contact metamorphic deposit. Production 4000 tons 1949. (Aubury 06:299; Bailey 02:13.)
	Nigger Head	Henry Olsen, Twenty-nine Palms (1943)	21 (?)	1S	13E	SB proj.	In Pinto Mts. Magnetite and hematite in quartz diorite, northwesterly strike vertical dip. Explored by 80-ft. vertical shaft and open cuts. (Tucker 43:471, pl.7.)
224	Old Dad Mountain (Reat, Riet)	Mineral Materials Co., 1145 Westminister Ave., Alhambra	13 or 14	12N	10E	SB	On Old Dad Mt. (Burchard 48:220; Lamey 48:59-67; Powell 48:3, tbl. 2; herein.)
	Owl Hole						See Black Magic. (Hodge 35, v.1:40; v.3,ap.E-5:10.)
	Paul						See Ship Mountains.

IRON (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Providence Mountain	Undetermined	34 (?)	11N	13E	SB proj.	In Providence Mts. 4 miles east of Kelso. (Boalich 23: 112.)
	Reat or Riet						See Old Dad Mountain.
	Schoebel	Paul Schoebel, Lenwood (1945)	10	3N	11E	SB	In Sheep Hole Mts. Accumulation of hematite boulders derived from small hematite segregations in olivine gabbro.
225	Ship Mountain (Paul)	I.F. Crosby, 1711 So. Kingsley Dr., and Charles A. Palmer, 1216½ So. Mariposa, Los Angeles; Earl W. Paul, 967 So. Marengo, Pasadena	11, 12	5N	15E	SB	South of Danby. (Burchard 48:220; Hewett 36:79; Hodge 35, v.1:44; v.3, ap.E-5:14; Lamey 48:113-116; Tucker 30:263-264; 31:335-336; 43:471, pl.7; herein.)
	Silver Lake						See Iron King and Iron Mountain.
	Specular	Undetermined	11 (?)	11N	12E	SB	Near Kelso. Vein of specular hematite in Cambrian dolomite. Production of 200 tons during World War I. (Hewett 36:78; Hodge 35, v.1:40; v.3, ap.E-5:10.)
	Tiefort Mountains (Bicycle Lake)	John H. Whitlock, Los Angeles, and Donald H. Frye, South Pasadena (1946)	22	14N	4E	SB proj.	In Tiefort Mts. Hematite in granite. Outcrop strikes N. 45° W., dips 60° SW.; 15-ft. shaft. Sample by Kaiser Corp. showed 68.20 percent iron, 0.022 percent sulphur. Within Camp Irwin Army Reservation. (Tucker 46:319.)
	Van Buren						See Morris Lode. (Tucker 43:471-473, pl.7.)
226	Vulcan	Kaiser Steel Corp., Fontana	25, 36	10N	13E	SB	In Providence Mts. SE of Kelso. (Bain 45:161-162; Burchard 48:217, 220; Cloudman 19:820-821; Hewett 36:79; Hodge 35, v.1:43; v.3,ap.E-5:12-13; Jones 09:785-788; 15: 1889; 16:308,315-317,318-323; Lamey 48:85-95; Lyon 14:40; Powell 48:2,6,tbl. 2; Ramsey 44; Thompson 29:32,679;

IRON (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
226	Vulcan (continued)						Tucker 24:43; 30:264; 31:336-337; 43:135-136, 473, pl.7; herein.)
	Western						See Bessemer.
227	Undetermined	Undetermined	32,33	12N	6E	SB	Northern Cave Mt. Lenticular magnetite-hematite ore bodies in NE trending sheared belt in diorite and mica schist. Several parallel series of lenticles 25 to 100 ft. long, and 5 to 20 ft. wide exposed in open cuts in zone about 250 yds. long, up to 100 ft. wide. Mining from two pods 125 ft. apart removed several thousand tons of ore of undetermined grade or destination. Idle.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
228	Aga	Otto F. Fuetterer, Baker	23, 24, 25, 26	14N	8E	SB	One mile northwest of Baker. Several quartz veins in granitic rock contain lead, silver, copper and gold. Numerous adits and trenches. No production. A prospect.
229	Alexander	Undetermined	9,10	19N	8E	SB proj.	South end of Alexander Hills. Two veins containing lead, silver, and zinc; in lower part of Noonday dolomite. West vein strikes N. 20°E., dips 60° to 70°E., mostly 2 to 6 ft. wide. Followed by 200 ft. adit and stope about 80 ft. in maximum dimension. East vein strikes N. 10°W. dips vertically; actually a group of small veins through zone 6 to 20 ft. wide. Adit at least 110 ft. long; stope about 100 ft. in maximum dimension. Long idle.
230	Anaco (Red Raven, Red Rover)	F.A. Rogers, Los Angeles (1943)	30,31	7N	5W	SB	Shadow Mts. about 5 miles north of Adelanto. Sphalerite and subordinate galena in replacement bodies in limestone along contacts with felsitic dikes. Developed by 100-ft. and 70-foot vertical shafts 300-ft. apart. (Tucker 30:267-268; 31:340-341; 43:474, pl.7.)
	Arctupus						See Ibex.
	Arcturus						See Ibex.
231	Avawatz Crown	Avawatz Consolidated Mines Co., Los Angeles (1943)	26	16N	6E	SB proj.	Silver Lake district. Brecciated quartzite contains silver-bearing galena and copper and zinc minerals. Workings consist of 325 ft. shaft and about 300 ft. of tunnel. Idle for many years. (Eric 48:298; Tucker 21:359-360; 30:268; 31:341; 43:474, pl.7.)
	Aviation	B.E. DelMar, Los Angeles (1935)	8	3N	2E	SB	San Bernardino Mts. Lead-silver prospect, also gold. Developed by open cut and adit. (Eric 48:298.)
	Bank Roll						See Keiper. (Tucker 24:92-93; 30:268; 31:341.)

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Barnett						See Lost Mormon. (Eric 48:298.)
232	Beck	Undetermined	31	20N	11E	SB proj.	NE. slope Kingston Range. Lead-silver-zinc prospect in Noonday dolomite. Adit several hundred feet long.
	Bell Gilroy						See C. and K. (Eric 48:299; Tucker 21:360; 30:268-269; 31:341; 43:475, pl.7.)
	Belle McGilroy (McGilroy)						See C. and K. (Cloudman 19:827; De Groot 90:532.)
233	Big Horn	Jerry Korfist, Baker	35	13N	10E	SB	North of Old Dad Mt. Siliceous zone in highly fractured dolomite. Zone about 300 ft. long and 2 to 5 ft. wide. Strikes E dips steeply N. Contains lead, silver and gold. A prospect.
	Black Peak	James R. Barker, 500 N. McCadden Pl., Los Angeles		9N	19E	SB	In Pinto Mts. Lead-silver prospect north of Highway 66.
	Blew Jordam						See Cucamonga Zinc.
234	Blue Bell (Hard Luck)	F.C. Baker, Barstow, leased to R.V. Waughtel, Manix.	27 (?)	14N	7E	SB	In Soda Mts. west of Baker. Also copper. (Herein.)
235	Blue Buzzard	L.R. Fayle, executor, Jane Frost Boggs estate 21 Boggs Bldg., 319 Fremont St., Las Vegas, Nevada	25 or 36	16N	13E	SB proj.	Ivanpah Mts. (Eric 48:299; herein.)
236	Bonanza King	South Acton Woolen Co. and Rawitzer Estate, South Acton,	3	10N	14E	SB	East slope Providence Mts. Lenticular, lead-silver orebodies along north-striking fissures in Paleozoic limestone. Developed by 540-ft. vertical shaft with 5 levels

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
236	Bonanza King (continued)	Mass.					at 100 ft. intervals and a winze from the 500-ft. level to the 800-ft. level. Also workings from numerous adits driven northwestward into hill above shaft. Total of over 20,000 ft. underground work. Produced high-grade silver ores as well as lead-silver. Reported to have produced at rate of $60,000 per month from 1883 to 1887. Latest period of extensive activity 1914-20. (Cloudman 19:827; Crawford 94:376; 96:330,606; De Groot 90:532; Eric 48:300; Irelan 88:500; Tucker 21:360-361; 24:198; 30:270; 31:342; 43:475, pl.7.)
	Bronze						See under tungsten.
237	Bullion	P. Hale, Nipton	10,15	15N	14E	SB	One of earliest mines in Ivanpah Mts. Shipped high grade silver-lead carbonate ores to Wales in 1860's and 1870's via Colorado River. Yielded about 250 tons of lead-copper-silver ore in 1916-17 from 200 ft. shaft inclined 45° but idle since. (Eric 48:300; Irelan 88:499; Tucker 30:270-271; 31:343; 43:475, pl.7.)
238	Burcham (Total Wreck)	Rose L. Burcham Estate, c/o John S. Chapman, 530 W. 6th St., Los Angeles	15,16 21	10N	1E	SB	Calico district. See general discussion of Calico district in silver section herein. Also produced gold. (Eric 48:300; Erwin 40:302-303; Tucker 21:351; 30:285-286; 31:358-359; 40:59-61; 40:242; 43:475-476, pl.7.)
239	C. and K. (Bell Gilroy, Belle McGilroy, Lead Capping, McGilroy)	Jack Rilance Estate, Portland, Oregon. Leased to James D. Harley, 4325 Gaviota, Long Beach.	9	10N	14E	SB	East slope Providence Mts. See also Fenner Smelting Co. (Cloudman 19:827; DeGroot 90:532; Eric 48:299; Tucker 21:360; 30:268-269; 31:341; 43:475, pl.7; herein.)
240	Cactus Flat (Morongo)	Mrs. Laura B. Walbeck, Big Bear Lake (1943)	19	3N	2E	SB	North slope San Bernardino Mts. Lead-silver minerals in granitic dike, 6 to 8 ft. wide, cutting limestone beds. Developed by 4 shafts and an adit. (Crawford 94:234; 96:

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
240	Cactus Flat (Morongo) (continued)						607; Crossman 90:228, 233; DeGroot 90:522; Irelan 88:503; Tucker 30:280; 31:353; 43:476-477, pl.7.)
	California Comstock		16	11N	18E	SB	See Leiser Ray under vanadium. (Eric 48:301.)
	California Hercules	Roy Kitching, 686 Elmira St., Pasadena (1943)	29,32	2N	6W	SB	Northeast slope San Gabriel Mts. Irregular deposits of lead and zinc ores occur in fractures in felsite bodies and along their contacts with limestone. Ore minerals are cerussite, sphalerite, and silver-bearing galena. Several cuts, adits and shallow shafts. (Tucker 43:477-478, pl.7.)
241	Carbonate	Riverside Portland Cement Co., Oro Grande (1940)	17	6N	4W	SB	Once the principal mine in the Oro Grande district and which gave the district its fame in the 1890's. Rich silver-lead and gold ore in veins. Developed by several shafts along half a mile length of shear zone in limestone; original shaft inclined to depth of 225 ft. Limestone part of Oro Grande series. (Cloudman 19:811-812; Crawford 94:26; 96:33,320,607; Crossman 90:230,233-234; Eric 48:301; Storms 93:361-363; Tucker 30:274; 31:347.)
242	Carbonate King	Beatrice Brackney, Arcadia, operated by O.B DeWitt, 778 Second St., San Bernardino	5 31	17N 18N	14E 14E	SB SB	Northeast of Clark Mt. Lead-silver-zinc mineralization along northeast-trending, vertical fracture in Goodsprings (?) dolomite, extends, along bedding planes for 25 ft. on each side of fracture. Principal ore body 3 to 4 ft. wide; traced laterally for 100 or more ft. Mined from 160 ft. adit, stopes and open cut. Another adit, 500 ft. long and 150 ft. lower was barren. Mine operated 1947, 1949-1951. (Tucker 30:274; 31:347; 43:478, pl.7.)
243	Carbonate King Zinc (Crystal Cave)	Crystal Cave Mining Co. Las Vegas, Nevada leased to J.Q. Little, Nipton.	4 32	15N 15½N	14E 14E	SB SB	West slope Kokoweef Peak in Ivanpah Mts. (Eric 48:301; Richards 44; Tucker 43:127-128; 43:478-479, pl.7. herein.)

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Carlyle						Dale district. Principally gold. Refer to gold section.
	Cave Springs Mining Corporation						See Imperial Lode. (Tucker 30:275; 31:347-348; 38:15.)
	Cerro de La Plata (Oro Plata)	R.J. McCausland, 315 N. Swall Dr., Beverly Hills					Old Woman Mts. Lead, silver and gold minerals in steeply dipping quartz veins in granitic rock. Developed by open cuts and 4 shafts, 30 to 170 ft. deep distributed along vein for 1200 ft. Owner reports total production about $7500. Idle. (Tucker 30:281; 31:354.)
	Chambers						See Silver Rule. (Eric 48:301.)
244	Columbia (Macedonia)	Mrs. R.P. Greenleaf, 450 So. Harvard, Los Angeles (1943)	3	11N	14E	SB	West slope Providence Mts. Lead, zinc and copper minerals carrying gold and silver occur in 2 parallel veins 80 ft. apart in quartz monzonite. Developed by 320-ft. inclined shaft with three levels; workings mostly water-filled. Last operated 1938 by Eau Claire Ore Co. (Eric 48:303,311; Tucker 21:340; 30:275; 31:348; 43:447, pl.7.)
245	Comet	Walter Thompson	24	13N	10E	SB	Lead-silver-gold deposit. Three shafts 80, 50, and 40 ft. deep. Worked in World War I.
	Copper Queen						In New York Mts. Copper-zinc-tungsten mine. See under copper.
	Crystal Cave						See Carbonate King zinc.
	Crystal Cones No. 4		4	15N	14E	SB	Probably part of Carbonate King Zinc which see. (Eric 48:303.)
246	Cucamonga Zinc (Blew Jordam)	Roland B. Lyttle, 2821 No. Sichel, Los Angeles	25	2N	7W	SB	On east slope of Cucamonga Peak. (Tucker 43:480, pl. 7; herein.)

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
247	Death Valley	J. Lee Strawn, Cima	11	13N	14E	SB	West of southern New York Mts. (Tucker 30:275-277; 31: 348-349; 43:480; pl. 7; herein.)
	Del Oro						See under gold.
	Desert Queen						See Imperial Lode. (Crawford 96:607; Storms 93:353-354.)
248	Eastern Star	L.W. Loomis	17	17N	10E	SB	South of Kingston Wash. Several lead- and silver-bearing veins in highly brecciated granite gneiss and quartzite (Archean). Two short adits 50 ft. vertically apart; small stopes and shallow winze. Small tonnage of high-grade ore.
	Emperor						See Vulture under copper.
	Fayle						See under copper. Also see Blue Buzzard herein.
249	Fenner Smelting Company	George Warren and Robert Hollingsworth, 345 So. Grand Ave., Los Angeles	34	9N	17E	SB	See C. and K.
	Fremont						See Nigger Mountain. (Eric 48:305.)
	Garfield	Garfield Lead and Silver Mines, Inc., Joseph Baumgartner, pres. Bakersfield (1943)	12 (?)	3N	1E	SB	East slope San Bernardino Mts. Irregular bodies of lead-silver ore along fault fractures in brecciated limestone. Fractures strike northwest, dip 50° northeast. Developed by 2 cross-cut adits having 400-ft. vertical interval. Small shipments of $80. ore made in 1932. (Tucker 43:480, pl. 7.)
250	Gemco	Walter Zindell and John Tunney, Essex	10	5N	17E	SB	Old Woman Mts. Vein in granitic rock contains galena, argentite, sphalerite and auriferous chalcopyrite. Principal value in silver. Workings consist of 800-ft. adit connecting with 60-ft. vertical shaft. Last operated by the Gray Eagle Mining Co. in 1936. Idle.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Gladstone						See Mowry. (Crawford 96:321; Storms 93:358-359.)
251	Gold Hill	Shadow Mountains Mines, Paul G. McKenry, pres., Nipton	10	17N	11E	SB	Shadow Mts. Nine miles northwest of Valley Wells. Formerly part of Foster Mines, which see under copper. (Tucker 43:480-481; herein.)
	Green Gold						See Keiper. (Eric 48:307; Tucker 24:92-93; 30:268; 31:341.)
	Halberg						See Mowry. (Storms 93:358-359.)
	Hard Luck						See Blue Bell.
	Homestake	H.E. Briggs, Trona, (1940)		Approx. 25S	44E	MD	In Slate Range. Lead-silver-gold mine. (Eric 48:307.)
	Hoosier and Missouri	J.W. Foglesong and E. Troutman, Barstow (1930)	28	10N	3W	SB	Near Hinkley west of Barstow. Gold-silver-copper-lead ore in quartz vein on contact of rhyolite and granite. (Cloudman 19:787; Eric 48:307; Tucker 30:214; 31:273.)
252	Ibex (Arctupus, Arcturus)	R.W. Busken, Leland Butts, and Leo Butts, Tecopa		20N	5E	SB proj.	In Black Mts. near Inyo County line. May be in Inyo County. Replacement ore bodies in dolomite. Ore in argentiferous galena and carbonates of lead and zinc. Mineralized seams along north-trending, steeply to gently dipping zone. Several shallow shafts and short adits. (Cloudman 19:821-822; Crossman 90:238-239; Norman 51:176; Tucker 21:287; 30:277; 31:350; 38:473; 43:481, pl. 7; Waring 19:96-97.)
253	Imperial Lode (Cave Springs Mining Corp., Desert Queen, Mammoth Chief, Meteor)	W.W. Tucker, 1425 W. Pico, Los Angeles	25, 36 1	7N 7N	5E 6E	SB SB	In Lava Bed Mts. (Crawford 94:376; 96:607; Crossman 90:231; DeGroot 90:529-530; Eric 48:308; Gardner 40:274-275; Storms 93:351-354; Tucker 21:362-363; 30:275-277-278; 31:347-348,360,351; 38:15; 40:244-245; 43:481, pl. 7, herein.)

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Imperial Lode Lease						See Imperial Lode. (Tucker 30:277-278; 31:350-351.)
254	Iron Horse (Jack Rabbit)	Tony Marteletti, 524 Linden, Las Vegas, Nevada	35 or 36	16N	13E	SB proj.	Ivanpah Mts. (Eric 48:308; Tucker 43:131-132; 43:483; pl. 7; herein.)
255	J. Juneau	Mr. and Mrs. T.W. Craig Goffs, via Fenner	10	11N	19E	SB	Northeast of Goffs on east slope small range between Dead Mts. and Piute Range. Galena in quartz vein in metamorphic rocks. Vein strikes N. 70° W, dips 45° SW. Explored by cuts and inclined shaft sunk on the vein to 50 ft. Short level workings at 40 ft. Some ore hauled to mill at Piute Springs and a few tons of concentrates shipped. Last worked late 1951.
256	Jackpot	F. Labe, Los Angeles (1941)	35	13N	12E	SB	Southwest of Cima. Lead mine with small amounts of copper, gold and silver. Last operated in 1941 by H.G. Barnes. (Eric 48:308.)
	Jack Rabbit						See Iron Horse.
257	Jackson (Stonewall, Stonewall Jackson)	R.A. Danielson Jr., and C.A. Bickel, 4455 N. Bannister, El Monte	9	17N	13E	SB	North Clark Mt. Silver, lead, gold ore in limestone replacement bodies. Several thousand ft. of workings resulted in production of several thousand ounces of silver from high-grade ores, mostly from 1889-90 and 1897. Small production 1922-29. Last operated 1936-42 but no production recorded. (Cloudman 19:826; Eric 48:317; Tucker 21:342; 24:94; 30:285; 31:358.)
258	Jeff Davis (Sunnyside Lode)	Byron Bluem, Harley Foster, and Robert E, Knepp, address unknown.	22	2N	3E	SB	East end of San Bernardino Mts. Stockwork of shallow-dipping quartz veins in schist body isolated in limestone. Contains argentiferous galena and free gold. Worked through a vertical shaft and a 70° inclined shaft cut at depth of about 100 ft. by a 200-ft. adit. Winze from adit goes to undetermined depth. Small but undetermined past production. Idle at least several years.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
259	Kally	D.H. Shire, 6910 Bonsallo Ave., Los Angeles	31,32	18N	14E	SB	North end Clark Mts. near state line. Two claims. Galena in replacement bodies in limestone. First mined 1917. Operated by lenses 1950-51, production of about 200 tons from open cut and short adits.
260	Keiper (Bank Roll, Green Gold, Kieper, Valentine)	G.B. Conklin, Valley Wells Station, P.O. Nipton	In unsurveyed area between 25	17N	12E	SB	In Clark Mts. (Eric 48:307; Tucker 24:92-93; 30:268; 31:341; 43:484, pl.7; herein.)
			and 30	17N	13E	SB	
	Kieper						See Keiper. (Tucker 43:484; pl.7.)
	Lady Luck	J.A. Bolard, Cima (1944)		15N	14E	SB	Clark Mt. district. Lead-silver-copper mine operated intermittently with small production in 1938, 1944 and 1945. (Eric 48:309.)
	Lead Capping						See C. and K.
261	Lead Mountain	Pacific Base Metals Co., A. Arthur Cohen, pres., 727 Subway Terminal Bldg., Los Angeles (1943)	36	10N	1W	SB	Lead Mt. west of Calico district. Mineralized fissure 100 ft. wide about 1300 ft. long in tuff and andesite porphyry carries crystalline barite with quartz containing iron oxides, galena, lead carbonate, manganese oxide, and silver chlorides. Developed for 500 ft. along strike on south side of Lead Mt. by 75-ft. crosscut and 33° inclined shaft 210 ft. deep. From north side of Lead Mt. 1300-ft. crosscut and 240-ft. raise connect with inclined shaft. Reported production of 20 tons daily in 1930. Total production undetermined. Worked in 1931-1933 for barite. Idle. (Tucker 24:199-200; 30:279,298; 31:351-352,372; 40:245; 43:484,509, pl.7.)
	Lost Mormon (Barnett)	Lost Mormon Mining Co., Long Beach (1938)		14N	16E	SB	New York Mts. Lead-silver-gold mine. (Eric 48:310.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
262	Lost Spanish	Undetermined	28	2N	3E	SB	Rattlesnake canyon, eastern San Bernardino Range. Narrow vein bearing argentiferous galena and lead carbonate. Small past activity; reopened briefly in 1950.
	Louisiana-California		15,22	11N	18E	SB	See Leiser Ray under vanadium.
	Mabel	Walter Zindell, Essex	3,10, 11	5N	17E	SB	Old Woman Mts. Lead-silver-gold minerals in quartz vein in granitic rock. Last operated by the Gray Eagle Mining Co. in 1934-35. Worked from 110-ft. inclined shaft. May be a part of the Gemco mine, which see.
	Macedonia						See Columbia. (Eric 48:311.)
	Mammoth						See Mammoth Chief and Imperial Lode. (Crossman 90:231.)
	Mammoth Chief						See Imperial Lode. (Crawford 96:607; Crossman 90:231; DeGroot 90:529-530; Storms 93:353-354.)
	McGilroy						See Belle McGilroy and C. and K. (Eric 48:311.)
	Meteor						See Imperial Lode. (Crawford 96:607; Crossman 90:231; DeGroot 90:529-530; Storms 93:353-354.)
263	Mitchell	J.E. Mitchell, Essex	21	10N	14E	SB	East slope Providence Mts. (Tucker 43:485, pl.7; herein.)
264	Mohawk	Ivanpah Copper Co., L.D. Godshall, Standard Oil Bldg., Los Angeles, leased to S.D. Greenwood and Emerson Ray, Valley Wells via Nipton	7,8, 17,18	16N	13E	SB proj.	Mohawk Hill on south slope Clark Mt. (Aubury 08:328; Eric 48:312; Tucker 21:363; 30:216,280; 31:275, 353; 43:485-486, pl.7; Wiebelt 49; herein.)
	Mohawk Zinc						See Nigger Mountain. (Eric 48:311; Tucker 43:69.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Morning Star						Formerly part of Imperial Lode, which see. (Crossman 90:231-232; Storms 93:353.)
	Morongo						See Cactus Flat. (Crossman 90:228,233; DeGroot 90:522; Ireland 88:503; Tucker 30:280; 31:353.)
265	Mowry (Gladstone, Halberg)	Roy M. Moury, 7011 Passaic St., Huntington Park	35	7N	5E	SB	North slope Lava Bed Mts. Lead-copper-gold-silver minerals along faulted, fractured and silicified zone in quartz porphyry. Zone more than 3000 ft. long and 30 ft. in maximum width. Workings distributed along 3000 ft. include 4 shafts, 100 to 250 ft. deep and 2 adits 105 and 310 ft. long. Western shaft water-filled at 60-foot level. Mine worked at intervals since late 1800's. (Crawford 96:321; Storms 93:358-359; Tucker 30:280-281; 31:353-354; 40:245-246; 43:486, pl.7.)
	New Era	Adolph Hansen, Cima		Approx. 15N	13E	SB	Ivanpah Mts. Lead-silver mine, also gold.
	New Era Mining Development Company						See New Era. (Eric 48:312.)
	New York						See Sagamore.
	Nichols	Undetermined		Approx. 2N	3E	SB	In Morongo district, east end San Bernardino Mts. Vein 12 ft. wide strikes northeast. Developed by 4 shafts from 20 to 100 ft. deep. (Cloudman 19:800; DeGroot 90:526; Tucker 30:245-246; 31:306.)
266	Nigger Mountain (Fremont, Mohawk Zinc)	F.L. Tomlinson, Lucerne Valley	22,23, 27	3N	1E	SB	East slope San Bernardino Mts. (Eric 48:305,311; Tucker 43:69; 43:486-487; pl.7; herein.)
	Oro Plata						See Cerro de La Plata. (Tucker 30:281; 31:354.)

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
267	Pedry	William Hile, Nipton and Mr. Martinson, Hemet. Leased to Fred Sanschi, Bagdad.	6,7, 18	10N	2W	SB	Northeast of Hinkley. (Herein.)
	Perseverence						Providence Mts. near Bonanza King. Probably now called the Silver King, which see. (DeGroot 90:532; Eric 48:314; Tucker 21:364-365; 30:281; 31:354.)
268	Piute	F.A. and R.W. Crampton, Cima (1919)	26	9N	18E	SB	Piute Mts. Lead-silver-gold property. Most active 1916-19. Developed by 400-ft. vertical shaft and 2000 ft. level workings. Production small. (Cloudman 19:816; Eric 48:314.)
269	Providence	P. Thibedeau, Kelso (1931)	10	11N	14E	SB	Providence Mts. east of Hayden. One claim. Lead-silver prospect. 300-ft. shaft with 3 levels. Idle since 1926. (Eric 48:315; Tucker 30:281-282; 31:354.)
270	Rainy Day	Jerry Korfist, Baker	27	13N	11E	SB	Northeast of Old Dad Mt. Lead-gold-silver in limestone. Shallow shaft and 2 short tunnels.
	Red Jacket	Algernon Del Mar, Victorville (1934)		2N	2E	SB	Black Hawk district San Bernardino Mts. Small production lead-silver-gold ore. Last operated 1934. (Eric 48:315.)
	Red Raven						See Anaco.
	Red Rover						See Anaco.
	Ross	R.B. Gill, 1020 N. Coronado, Los Angeles		Approx. 15N	13E	SB	Ivanpah Mts. Small output of lead-silver-gold ore. Last operated 1926-27. (Eric 48:316.)
	Sagamore (New York)	Claremont Mining Co., 336 W. 2nd St., Claremont	33,34	14N	16E	SB proj.	South slope New York Mts. See also under copper and tungsten. (Aubury 08:831-833; Cloudman 19:790; Eric 48:316; Jenkins 42:350; Partridge 41:308; Tucker 30:220; 31:279;

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Sagamore (continued)						43:67-68,436.)
	Sampson						Formerly part of Imperial Lode, which see. (Crawford 96:609; DeGroot 90:529-530; Storms 93:353.)
	Santa Fe						See under gold.
271	Scotty Wilson	D.F. Gleber, 1036 Ferris Ave., Los Angeles Leased (1951) to Phillip Barnes and associates, Box K., Big Bear Lake	4	2N	1E	SB	In Van Dusen Canyon. Also a uranium prospect. (Herein.)
272	Silver Bell	Rare Metals Corp., Mrs. O.J. Bellamy, Inglewood (1943)	12	7N	4E	SB	North slope Lava Bed Mts. Amygdaloidal basalt flows cut by parallel northwest-striking fractured zones. Amygdules filled with calcite near fractures. Zones explored by 1050-ft. cross-cut adit. Silver-lead-gold reported. Small mill on property. (Tucker 30:282-283; 31:355-356; 40:246; 43:487, pl.7.)
	Silver Bell Development Co.						See Silver Bell. (Tucker 30:282-283; 31:355-356.)
	Silver Cliff						See Silver Reef. (Tucker 30:283-284; 31:356-357; 43:487-489, pl.7.)
273	Silver Dream (Tiptop)	R.A. Saviers, P.O. Box 3, Big Bear City. Leased (1951) to J.L. Harper, 406 N. Ardmore, Los Angeles	17	2N	3E	SB	Near crest of Tiptop Mt. east of Big Bear City. (Herein.)
274	Silver King (Perseverence)	Undetermined	34	11N	14E	SB	Providence Mts. near Bonanza King. Probably a new name

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
274	Silver King (Perseverence) (continued)						for the Perseverence. Lenses of argentiferous galena and silver chlorides and bromides in Paleozoic limestone. Trend of orebodies N. 25° to 40° E. dip 75° SE. to vertical. Main shaft reported to be 162 ft. deep with levels at 40, 72 and 160 ft. About 20 ft. northeast of shaft is open cut and partly caved shaft. Crosscut adit driven northwest from near collar of shaft. Other exploration pits and an adit several hundred ft. southwest. Perseverence is an old property, one claim having been patented in 1890. Total production undetermined. Long idle. (DeGroot 90:532; Eric 48:314; Tucker 21:364-365; 30:281; 31:354.)
275	Silver Reef (Silver Cliff)	W.C. Buehler, Wesley N. Rowe, Betty Jean Mullinix, 1555 Sunset Ave., Pasadena (1951)	18	7N	5E	SB	Northeast slope Newberry Mts. Lead-silver prospect in brecciated zones in limestone. Three shafts 80 to 360 ft. deep, and several hundred feet of tunnels at various levels. No recorded production. (Tucker 30:283-284; 31:356-357; 43:487-489, pl.7.)
276	Silver Rule (Chambers)	John Prato, 2134 W. Valley, Fontana	19	20N	10E	SB proj.	In Resting Springs district of Kingston Mts. Has been recorded in Inyo County and described in some Inyo County reports. (Eric 48:301,317; Hazzard 37:298; Norman 51:186; Sampson 37:268; Tucker 2[illegible]:365-366; 26:5[illegible]; 3[illegible]:284; 31:357; 38:455,479; 43:489, pl.7; Waring 19:108; herein.)
277	Silver Wave		4	5N	17E	SB	Old Woman Mts. Lead-silver mine last operated in 1902 when production is reported to have been $15,000. Workings consist of 4 strike adits driven N. 15° - 25° W. on a quartz vein in metamorphic rocks, within a vertical distance of several hundred feet. The millsite has been relocated as part of the Packard Tungsten property. (Bailey 02:-10.)
	South Western Lead Company	E.W. Fisher, Bagdad (1913)					Once operated War Eagle mine, which see. (Eric 48:317.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
278	Spar King	A.E. Weidman and Jerry Korfist, Box 75, Baker	31,32	$17\frac{1}{2}$N	13E	SB	North Clark Mt. silver-lead prospect. Oxidized siliceous zone in massive dolomite. Explored by 100-foot shaft. Production undetermined. Idle.
	Standard						See under copper and Riley under tungsten.
	Standard No. 2						See under copper.
	Stonewall		10	17N	13E	SB	See Jackson. (Cloudman 19:826; Eric 48:317; Tucker 21:342; 24:94; 30:285; 31:358.)
	Stonewall Jackson						See Jackson. (Eric 48:317.)
	Sulphide Queen						See under gold.
	Sunnyside Lode						See Jeff Davis.
	Sunshine Copper Company	C.M. McFarlane, Parker, Arizona					In Bullion Mts. south of Mt. Pisgah. Probably operated Tip Top copper-silver mine, which see under copper. (Eric 48:317.)
	Tip Top						See Silver Dream.
	Total Wreck						See Burcham. (Tucker 21:351; 30:285-286; 31:358-359.)
	Tri-metal	Lessees (1942) E.M. Hinshaw and G.B. Hogason, 91 W. Jackson St., Tucson, Arizona	6(?)	2N	23E	SB proj.	In Whipple Mts. Lead and zinc carbonates in vertical shear zone striking N. 10° W. in metamorphic rocks. Developed by 70-ft. shaft and open cuts. A prospect.
	Valentine						See Keiper.
	Victor						See under gold.

LEAD-SILVER-ZINC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
279	War Eagle	L.W. Osborne, Los Angeles (1943)	2,3	4N	10E	SB	Eastern slope Lead Mt. in Bullion Mts. Incline shaft sunk 700 ft. on vein which strikes N. 60° W. dips 40° SW following fault zone in rhyolite. Over 7[illegible] ft. of workings on 6 levels at intervals of 100 ft. The vein contains galena and cerussite with some silver chloride and bromide minerals and wulfenite and vanadinite. First worked 1905-08. Last worked 1949. (Eric 48:319; Tucker 21:366; 24:95-96; 30:286; 31:359; 34:325; 43:489, pl.7.)
	Wonder Mountain	Wonder Mountain Mines, Inc., L.G. Blakemore, pres.	15	17N	14E	SB	Clark Mt. district. Lead-silver and gold in replacement ore bodies along fractures in altered limestone near intrusive monzonite. Developed by short adit and shallow shafts. (Tucker 43:490, pl.7.)
280	Yucca (Yucca Queen)	Yucca Metals Mining Co. J. Rimensberger, pres., pres., Salt Lake City, Utah	8,17	16N	13E	SB proj.	Clark Mt. district. (Eric 48:319; Tucker 43:491, pl. 7; herein.)
	Yucca Queen						See Yucca.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Andreen	H.M. Andreen (1918)	18	8N	8E	SB	Prospect north of Ludlow. (Trask 43:160, 50:88.)
281	Big Reef (Black Butte, Matt and Pisgah)	Kenneth and C.S. Van Doren, 476 Barbour Ave. Banning	10	8N	6E	SB	In Cady Mts. area (Agey 52:1,3-5; Trask 43:62, 66,84,85, 160; 50:188-191; Tucker 40:241; 43:492-493, pl.7; herein.)
	Black Beauty	R.A. Koontz, Anaheim, W.H. Kimball, Jr., Seal Beach and H.E. Ellis estate		15N	6E	SB	Within Camp Irwin Military Reservation. (Trask 43:160; 50:191.)
	Black Butte						See Big Reef. (Tucker 40:241; 43:492-493, pl.7.)
	Black Chief						See Dawson.
282	Black Magic (Emma)	Jack Helliard, Beatty, Nevada and Roy Watkins, Baker	5,8	18N	3E	SB proj.	Southeastern part of Owlshead Mts. Pockets of manganese oxides in breccia of limestone and granite. Largest pockets contain only few tons of ore. Total production through 1942 was 302 tons averaging 34.8 percent manganese. (Bradley 18:62,95; Trask 43:61,84,85,160,161; 50:195; Tucker 21:354, 30:264-265; 31:337; 43:493, pl.7.)
283	Black Mountain (Gallagher)	T.E. Gallagher, J.W. Arrington, Needles	17, 20	10N	22E	SB	In Dead Mts. northwest of Needles. Small scattered lenses of psilomelane and calcite in granodiorite gneiss. A few hundred pounds produced since 1918. (Trask 43:66,84,160; 50:191-192; Tucker 43:493, pl.7.)
	Black Prince						See Manganese Cliff.
	Black Raven (Lankin)	Hans Von Lankin and Mr. Wagner, Newberry (1918)	4	8N	3E	SB	On north face of Newberry Mts. Stringers and narrow veinlets of black calcite enclose narrow, discontinuous bodies of psilomelane along shear zone in rhyolite agglomerate. (Trask 43:62,66,160; 50:193-194.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Black Stone	J.H. Massen, Yermo	28	11N	6E	SB	East of Mojave River 3 miles SE. of Afton. Lenses of manganese oxides occur along 1000 ft. of contact between granite and limestone. No production. (Trask 43:62,66, 84,160; 50:194; Tucker 21:354; 30:264; 31:337.)
	Black Tiger						See Orchard. (Tucker 43:67, 493, pl.7.)
	Cactus Central	W.H. Miller, Pasadena (1943)	6	2N	26E	SB	In Whipple Mts. adjoining Monument King. Same type of deposit. (Tucker 43:494,pl.7.)
	Cross Roads						See Monument King.
	Dawson (Black Chief, McDowell)	J.H. Dawson, Parker Dam	32 or 33	4N	26E	SB	Half a mile west of Lake Havasu. Narrow stringers of manganese oxides fill fissures in Quaternary basalt. No production. (Jones 19:185,186,187-188,189-190; Trask 43: 62, 161; 50:194-195; Tucker 21:355.)
	Dunbar						See Orchard.
	Emma						See Black Magic. (Bradley 18:62,95; Trask 43:84,85,161; 50:195; Tucker 21:354; 30:264-265; 31:337.)
	Gallagher						See Black Mountain.
	Garringer						See Lee Yim. (Cloudman 19:822.)
	Hidden Cross						See Monument King.
	Hidden Treasure						See Monument King. (Jones 19:185, 186,187,188,189,190-193; Trask 43:161; 50:202-203; Tucker 21:355-356; 30:265-266; 31:338-339.)
	Juleff						See Moulton. (Tucker 43:494,pl.7.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Lankin						See Black Raven.
	Lavic Mountain						See Lee Yim. (Bradley 18:62,95; Tucker 21:354-355; 30: 265; 31:337-338; 43:132-133, 494,pl.7.)
284	Lee Yim (Garringer, Lavic Mountain, Manganese 1-10, Root)	Lee W. Yim, Amboy	22, 23	8N	7E	SB	In Cady Mts. area. (Agey 52:1,11-14; Bradley 18:62,95; Cloudman 19:822; Hewett 36:86; Hodge 35, v. 4, ap. M:15; Trask 43:62,66,84,85,161; 50:195-200; Tucker 21:354-355; 30:265; 31:337-338; 43:132-133, 494, pl.7; herein.)
285	Logan (Trans-Oceanic, Treasure)	E.F. Logan, San Bernardino	28, 32	9N	6E	SB	In Cady Mts. area. (Agey 52:1,5-9; Trask 43:62,66,84,85, 162; 50:200-201; Tucker 43:495, pl.7; herein.)
	Manganese 1-10						See Lee Yim.
	Manganese Cliff (Black Prince, Manganese King)	Kenneth and C.S. Van Doren, 476 Barbour Ave., Banning	4, 5	17N	4E	SB proj.	On north slope Avawatz Mts. within Camp Irwin Military Reservation. Small veins of manganese oxide in brecciated andesite. (Bradley 18:61-62, 95; Trask 43:160; 50:192-193; Tucker 43: pl.7.)
	Manganese King						See Manganese Cliff also Monument King. (Tucker 43:495, pl.7.)
	Matt Pisgah						See Big Reef.
	McDowell						See Dawson. (Jones 19:185,186,187-188, 189-190: Tucker 21:355.)
286	Monument King (Cross Roads, Hidden Cross, Hidden Treasure, Manganese King)	Paul Robison, Ogden, Utah and Mrs. Ray Siedletz, 2621 Whittier Blvd., Los Angeles	1 36	2N 3N	25E 25E	SB proj. SB	In Whipple Mts. (Jones 19:185,186,187,188,189,190-193; Trask 43:63,66,85,162; 50:202-203; Tucker 21:354-355; 30: 265-266; 31:338-339; 43:495, pl.7; herein.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
287	Moulton (Juleff, Red Cross)	C.E. Moulton, Cross Roads (1943)	6	2N	26E	SB	In the Whipple Mts. Deposits are similar to the Monument King described herein. Developed by open cuts. (Hodge 35, v.4, ap. M:16; Jones 19:185,186,187,188,189,190-193; Trask 43:63,66,85,162; 50:203; Tucker 21:355-356; 30:265-266; 31:338-339; 43:494, pl.7.)
288	New Deal (Old Hole, Owls Head, Owls Hole)	L.K. Orwig, 1079½ Leighton Ave., Los Angeles	16	18N	3E	SB	In southeastern part of Owlshead Mts. (Bradley 18:19, 62,95; Cloudman 19:822,823; Hewett 36:86; Hodge 35, v. 4, ap. M:16; Trask 43:61,62,66,84,85,163; 50:203-205; Tucker 21:354,355; 30:264,265; 31:337,338; 43:495-496, pl.7; herein.)
	Newberry						See Black Raven, Northrup and Turner. (Tucker 40:241.)
	Northrup	Mr. Northrup (1918)	8	8N	3E	SB	North slope Newberry Mts. Similar to Black Raven. (Trask 43:62,66,163; 50:205.)
	Old Hole						See New Deal.
	Orchard (Black Tiger, Dunbar)	Charles Dunbar, Parker Dam. Leased to Albert Sterkin, 2920 10th St., Santa Monica	10	3N	26E	SB	North of Whipple Mts., one mile west of Lake Havasu. Manganese oxides cementing agent in fanglomerate. Ore minerals probably emplaced along fissures. Explored by 50-ft. adit. No production. (Trask 43:61,66,84-85; 50:205-206; Tucker 43:493,pl.7.)
	Owls Head						See New Deal.
	Owls Hole						See New Deal. (Bradley 18:19,62,95; Cloudman 19:822,823; Hewett 36:86; Hodge 35, v. 4, ap. M:16; Trask 50:203-205; Tucker 21:354,355; 30:264,265; 31:337,338; 43:495-496, pl. 7.)
	Owls Spring	Undetermined	18	18N	3E	SB	West of Black Magic deposit. Bedded manganese oxides in Tertiary lake beds. Low grade. (Trask 43:61,66,84,163; 50:206.)

MANGANESE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Proctor	Elmo Proctor, Yermo					In Cronese Valley near Dunn. Manganese oxides in fissure in andesite. (Agey 52:1,9-11.)
	Red Cross						See Moulton. (Hodge 35, v.4,ap. M:16; Jones 19:185,186, 187,188,189,190-193; Trask 50:203; Tucker 21:355-356; 30: 266; 31:338-339.)
	Reinerth	E.A. Reinerth, Ludlow	5	8N	8E	SB	In Cady Mts. area north of Ludlow. Manganese oxides in fissures in brecciated rhyolite. Total production 10 tons. Deposit mined out. (Trask 43:164; 50:206.)
	Root						See Lee Yim. (Hewett 36:86; Hodge 35, v.4, ap.M:15.)
289	Stewart	J.W. Stewart, Vidal	6	3N	25E	SB	North slope Whipple Mts. (Trask 43:62,66,84,85; 50:206-207; Tucker 43:135, 496-497, pl.7; herein.)
	Trans-Oceanic						See Logan. (Agey 52:1,5-9.)
	Treasure						See Logan.
	Turner	M.C. Turner, (1918)	9(?)	8N	3E	SB	Prospect in Newberry Mts. (Trask 43:164; 50:207.)

MERCURY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	City Creek	Undetermined					South slope San Bernardino Mts. "A cinnabar-bearing ledge on City Creek, 6 miles from San Bernardino". Worked prior to 1873. (Bradley 18:123.)
	Desert Mercury	S.M. Mingus and associates Glendale (1930)	33	7N	17E	SB	In Old Woman Mts., east of Danby. Mercury minerals in quartz porphyry dikes. (Ransome 39:476; Tucker 30:266; 31:339.)
	Idria						Probably now known as Turtle Dove, which see. (Ransome 39:476; Tucker 30:266-267; 31:339-340.)
	Jack						See also under tungsten. Cinnabar associated with wolframite. (Bradley 18:123; Hess 17:47, pl.5.)
	Mercury						Probably now known as Turtle Dove, which see. (Bradley 18:123; Ransome 39:476.)
	Myrick	F.M. Myrick, Randsburg (1923)		18N	1E	SB proj.	Northeast of Lead Pipe Springs. Inclusions of cinnabar in chalcedony in volcanic rocks. Given the name "myrickite" and used as gem stone. In 1912 was investigated as possible source of mercury. See under gem stones. (Bradley 18:123; Cloudman 19:863; Newman 23:63.)
	Red Bird	C. Davson	28	9N	3W	SB	West side Mojave River, south of Hinkley.
	Red Canyon	Roy B. Stephenson, 1567 "G" St., San Bernardino		2N	2E	SB	South slope San Bernardino Mts., southeast of Lake Erwin. Cinnabar sparsely disseminated in iron-stained gouge along fault zone between quartzite and siliceous limestone.
	Red Chief	W.D. Ford, J.M. Herrera and V.B. Willets	17,18	14N	16E	SB	New York Mts., on northwest side Keystone Canyon.

MERCURY (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Red Fox	W.T. Elliot	28	3N	5W	SB	Near Cajon Pass, San Bernardino Mts.
	Redlead	S.E. Kennedy		7N	22E	SB	In Sacramento Mts., southwest of Needles.
	Rhumba	L.E. Martin, Box 352, Barstow (1941)					Fourteen miles north of Barstow. Sparsely disseminated cinnabar in shear zone in granitic rock.
	Turtle Dove (probably new name for Idria and Mercury groups)	F.W. Cooke, Nelson, Nevada (1942)	24	9N	18E	SB	Piute Mts., 4 to 5 miles south of Goffs. Cinnabar sparsely disseminated in silicified fracture zone in granitic gneiss.

MOLYBDENUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
290	Big Hunch (Brooke)	J.F. Brooke and F.M. Brooke, Barstow (1943)	35	14N	15E	SB	South end New York Mts., quartz vein as much as 50 ft. thick; dips moderately north, cuts granite. Contains disseminated molybdenite, said to be the richest near footwall. Inclined shaft 250 ft. deep sunk 1917-18. Joined to adits at 120-ft. level. Short tunnels at 200- and 250-ft. levels. Yielded small output of concentrates. Ore samples said to average 1.8 percent molybdenite. (Tucker 41:584; 43:497.)
	Brooke						See Big Hunch.

RARE EARTH ELEMENTS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
291	Bullsnake group	Walt Bilicke, 5011 Hollywood Blvd., Hollywood	12,13	16N	13E	SB proj.	Undeveloped claims in Mountain Pass district, $\frac{1}{2}$ mile north of highway, east of Mountain Pass mine.
292	Horseshoe group	A.T. Hampton, 732 N. Catalina and Claude Hampton, 2531 Buena Vista, Burbank	30	16N	14E	SB	Undeveloped claims in Mountain Pass district, $\frac{1}{2}$ mile north of highway, east of Bullsnake group.
293	Lucky Strike group	P.A. Simons, Jean, Nevada	24?	16N	13E	SB proj.	Undeveloped claims in Mountain Pass district, $\frac{1}{4}$ mile south of Highway 91, on Mescal Spring Road.
294	Mineral Hill Claims	Emerson Ray and Naaman Willmore, Nipton and Carl Welch, San Bernardino	19	$15\frac{1}{2}$N	14E	SB	Undeveloped claims in Mountain Pass district, $1\frac{1}{2}$ miles south of Highway 91 on Mescal Spring road. Shear zone 2 to 25 ft. wide and 5000 to 6000 ft. exposed length cuts pre-Cambrian granitic gneiss. Minerals include barite, calcite, siderite, and rare-earth minerals. Explored for 4000 ft. along strike by bulldozer cuts. Numerous shallow pits and trenches.
295	Mountain Pass	Molybdenum Corporation of America, Nipton	12,13	16N	13E	SB	Mountain Pass (east Clark Mt.) district. See Sulphide Queen under gold. (Herein.)
296	Rathburn group	Frank Rathburn, Nipton (Wheaton Springs)	31	16N	14E	SB	Undeveloped claims in Mountain Pass district, south of highway, east of Mineral Hill group.
	Sulphide Queen						See under gold. Also see Mountain Pass mine.
297	Summit group	A.F. Carper, Las Vegas, Nevada, S.A. Dixon, Nipton (Wheaton Springs), and J. Riley Bembry, Cima	29,30, 31,32	$15\frac{1}{2}$N	14E	SB	Undeveloped claims in Mountain Pass district, 2 miles south of highway, south of Mineral Hill group.

RARE EARTH ELEMENTS (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
298	Windy Boy group	Roy Watkins and Bill Benson, Nipton (Mountain Pass)	29	15½N	14E	SB	Claims in Mountain Pass district. 2 miles south of highway, east of Summit group. Veins as much as 4 ft. wide exposed discontinuously for several hundred ft. along strike.

SILVER

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Agnes	C.L. Haythorne, Nipton	21	16N	13E	SB proj.	Westernmost Ivanpah Mts. Thin, oxidized, mineralized layers with silver and gold in bedding in fractured gray limestone. Developed by 150-ft. shaft with 235 ft. drift northeast at bottom, and 800 ft. of drifts and crosscuts on the 32-ft. (adit) level. Most recent production in 1937. Total production undetermined. Idle.
299	Akron-Silver Reef (Silver Reef)	J.J. McLaughlin, 135 So. Commonwealth, Los Angeles	3,4 33,34	3N 4N	2E 2E	SB SB	Black Hawk district, southwest of Lucerne Valley. (Cloudman 19:828-830; Crawford 94:377; 96:328; De Groot 90:533; Eric 48:317; Storms 93:365-366; herein in silver section under "Mines in other areas.")
300	Alabama-Mountain View-Snowbird group	Mrs. J.R. Lane, Yermo	14,15	10N	1E	SB	Southeast end of Calico district. Adjacent to and south of Blackfoot group. Cerargyrite and embolite in fractures and seams in brecciated rhyolite tuff. Developed by short adits and open cuts. Long idle. (Tucker 30:claim map, opp. p. 270; 31: claim map, opp. p. 344; 40:242.)
301	Alta	Undetermined	24 19	17N 17N	8E 9E	SBproj. proj. SB	Western Silurian Mts., north of Baker. Incorrectly referred to as Riggs mine in some previous descriptions. Active 1910-1912 and 1920; production undetermined. Long idle.
302	Annex (Silver Hills)	George Peterson and Albert E. Barton	26	17N	8E	SB proj.	Silurian Mts. (Described in silver section under "Mines in other areas.")
303	Argentum group	Henry W. Britt, Daggett	10,15	10N	1E	SB	Calico district. Along Garfield fault adjoining Calico-Odessa group on west. Chlorides and chloro-bromides of silver occur in irregular fractures and joints in rhyolite tuff. Developed by several open cuts and tunnels. Long idle. (Tucker 30:claim map, opp. p. 270; 31:claim map opp. p. 344; 40:242.)
	Baltic	Mrs. J.R. Lane, Yermo	14,15	10N	1E	SB	Calico district. Part of Calico-Odessa group. (Tucker 30:

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Baltic (continued)						claim map opp. p. 270; 31:claim map, opp. p. 344.)
	Barber Mining and Milling Co.						Calico district. Former operator of a 10-stamp mill and several mining claims, including the Harmonial, Ironclad, Silver Reef, Smelter, Three Total Wrecks, and Voca, all on extension (?) of Waterloo vein. See Voca under Waterloo, in discussion of West group in Calico District herein. (Irelan 88:495-496.)
304	Belcher Extension	Belcher Extension Mining Co., Inc. (1925)	7	30S	41E	MD	Prospect in Randsburg area. Vertical shaft 432 ft. deep; levels at 232,332, and 432 ft. contain about 300 feet of workings. Encountered 3 veins; material assayed as much as 20¢ in gold and 24. oz. silver per ton. No ore mined. (Hulin 25:128-129; Tucker 30:268; 31:341.)
	Bevis Divide	Bevis Divide Mining Co.	7	30S	41E	MD	Prospect in Randsburg area. Vertical shaft 150 ft. deep. No ore encountered. (Hulin 25:129; Tucker 30:269; 31:342.)
	Big Four	Rand Consolidated Silver Mining Co. Inc., (1925)	32	29S	41E	MD	Prospect in Randsburg area. Vertical shaft, 1300 ft. deep, entirely in Tertiary sandstone. (Hulin 25:129; Tucker 30:269; 31:342.)
	Big Six	Undetermined	7	30S	41E	MD	Prospect in Randsburg area. Vertical shaft, 250 ft. deep, passes through Tertiary sandstone into quartz monzonite. (Hulin 25:130; Tucker 30:269; 31:342.)
305	Bismarck	Mrs. J.R. Lane, Yermo	10,15	10N	1E	SB	Part of Calico-Odessa group described in discussion of east group, Calico district. (Crawford 96:607; Erwin 40:301; Irelan 88:497; Lindgren 87:723-724; Storms 93:338-344; Tucker 40:244.)
306	Blackfoot (Blackfoot-Golconda)	Mrs. J.R. Lane, Yermo	13,14	10N	1E	SB	Calico district. Part of Calico-Odessa group. See east group discussion herein (Erwin 40:302; Lindgren 87:726-727; Tucker 30:269; 31:342; 40:242.)

SILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Blackfoot-Golconda						Calico district. See Blackfoot and Calico-Odessa group. (Tucker 30:269; 31:342.)
307	Bray and Bisbee	Rand Silver King Mining Co. (1925)	6	30S	41E	MD	Randsburg area. Vertical shaft, 587 feet deep, with 4 levels and about 5000 ft. of workings. On extensions of veins from Kelly and Coyote workings; mostly low-grade, locally constituting ore. Best ore probably on 450-foot level. (Hulin 25:131-132; Tucker 30:270; 31:343.)
238	Burcham (Total Wreck)	Rose L. Burcham Estate, c/o John S. Chapman, 530 W. 6th St., Los Angeles	15,16, 21	10N	1E	SB	Calico district. Gold-silver-lead. See west group discussion herein. (Erwin 40:302-303; Lindgren 87:727; Tucker 21:351; 30:285-286; 31:358-359; 40:59-61, 242-243; 43: 475-476.)
	Calico-Odessa group (Baltic, Bismarck, Blackfoot, Garfield, Occidental, Odessa, Thunderer)	Mrs. J.R. Lane, Yermo (1943) formerly Calico-Odessa Mining Co., J.R. Lane, pres., 612 I.W. Hellman Bldg., Los Angeles (1931)	10,11, 14,15, 23	10N	1E	SB	Calico district. See east group discussion herein. (Crawford 96:606,607,608; Eric 48:301; Erwin 40:301-302; Goodyear 88:510-511; Irelan 88:497,510-511; Lindgren 87:723-726; Storms 93:343; Tucker 21:360,362,363,pl.6; 30:271; 31:343-345; 40:243-244, 43:477.)
	California Rand						See Kelly.
308	Carbonate	J. Mulcahy, 998 14th St., San Bernardino	23	10N	1E	SB	Calico district. Silver minerals impregnated in tuffs. Between Bismarck and Odessa Canyons at their junction. Picked breccia ore had as much as 25 ozs. silver, 0.187 oz. gold, 19 percent lead. Developed by several hundred feet of surface cut and short adits. Idle.
	Carlyle						See under gold. Pyrargyrite, polybasite and stephanite associated with gold and galena. High grade silver ore shoots in vein. (Tucker 43; 444-445.)
	Chicken Hawk		7	30S	41E	MD	Prospect in Randsburg area. Vertical shaft, 204 ft. deep,

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Chicken Hawk (continued)						passed through Tertiary sandstone into quartz monzonite. (Hulin 25:132; Tucker 30:275; 31:348.)
	Cima Bimetallic		31	29S	41E	MD	Prospect in Randsburg area. Vertical shaft, 200 ft. deep. Seems entirely in Rosamond formation. (Hulin 25:132.)
	Comet	Undetermined	14(?)	10N	1E	SB	Calico district, $1\frac{1}{4}$ miles east of townsite. Vein dips steeply south, is 6 to 8 ft. wide, carries silver chloride in barite gangue. Ore shoots are pockety with richest streaks shallow. Developed by adit which meets vein at 75-ft. depth. Lessees produced ores ranging in grade from 35 to 950 ozs. of silver per ton. Long idle. (Irelan 88:499.)
309	Consolidated, Consolidated Extension (St. Louis)	G.A. Hoffman	15	10N	1E	SB	Calico district. See central group discussion herein.
310	Coyote	Frank Royer, Red Mountain	6	30S	41E	MD	Randsburg area. Coyote shaft, 750 ft. deep and vertical, has more than 6000 ft. of appended level workings. Best ore on 5th level in southern extension of Harrell vein. Coyote East vein also exposed on 5th level. (Hulin 25:133-134; Tucker 30:272; 31:345.)
	Cuba	Mrs. J.R. Lane, Yermo		10N	1E	SB	Calico district. Calico-Odessa group. Pockety ore deposit in "porphyry" carrying barite and cerargyrite. Developed by adits 50 and 300 ft. long. Production undetermined. (Irelan 88:496.)
311	Dietzman group	Oro Grande Mining Co. (1940)	23	10N	1E	SB	Calico district adjoining Baltic group on the east. Chlorides and chlorobromides of silver in brecciated rhyolite tuff. Developed by open cuts and short adits. Long idle. (Tucker 30:claim map, opp. p. 270; 31:claim map, opp. p. 344; 40:244.)

SILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
312	Falls (Sioux, Sue)	Alberta Osborne and A. McCuistion, Daggett	15	10N	1E	SB	Calico district. Described in duscussion of central group in text. (Lindgren 87:pl.6; Tucker 21:pl.6; 30:claim map, opp. p. 270; 31:claim map, opp. p. 344.)
313	Flat Tire	Southern Mining and Milling Co. (1925)	5	30S	41E	MD	Randsburg area. Vertical shaft, 1560 ft. deep, through Tertiary sandstone, into Rand schist. No ore encountered. (Hulin 25:134; Tucker 30:277; 31:350.)
314	Fox lease		6	30S	41E	MD	Randsburg area. Vertical shaft 775 ft. deep; 1150-ft. crosscut at bottom driven southeastward through quartz monzonite into Rosamond sandstone. Crosscut encountered three veinlets and large brecciated vein. No ore produced (Hulin 25:134.)
315	Galena King (Revier)	James Seymour, J.A. Weilage, C.E. Ballard, Rte. 1, Barstow	5	10N	1E	SB	Calico district, northwest end. Barite-jasper vein in brecciated volcanic rocks. Explored in several places for about $\frac{1}{2}$ mile along strike by shallow shafts, winzes, open cuts. Recent work but production small, if any.
316	Garfield (Garfield-Thunderer)	Mrs. J.R. Lane, Yermo	14, 15	10N	1E	SB	Calico district. Part of Calico-Odessa group. Refer to east group discussion herein. (Crawford 96:608; Erwin 40:301-302; Goodyear 88:510-511; Irelan 88:497,511; Lindgren 87:724-726; Tucker 21:362,pl.6; 30:271; 31:344; 40:243-244; 43:477, pl.7.)
	Garfield lease						See Garford Lease. (Tucker 30:277; 31:350.)
	Garfield-Thunderer						Calico district. See Garfield, part of Calico-Odessa group.
317	Garford lease	George H. Clapp, Sewickley, Penn.	7	30S	41E	MD	Randsburg area. See Black Hawk under gold. Vertical shaft, 300 ft. deep, with levels at 85, 200, and 300 ft.; workings 1000 ft. in total length; explores most southerly part of Footwall vein. Mineralization was erratic and

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
317	Garford Lease (continued)						high grade extension from Kelly mine area not found. No production. (Hulin 25:135; Tucker 30:277; 31:350.)
	Good Morning		7	30S	41E	MD	Prospect in Randsburg area. (Hulin 25:144.)
	Grady and Sill lease (Grady lease)						Part of Kelly mine. (Hulin 25:117-118; Newman 23:61; Tucker 30:277; 31:350.)
	Grady Extension		7	30S	41E	MD	Prospect in Randsburg area. (Hulin 25:144.)
	Grady lease						See Grady and Sill lease.
	Grady No. 1 and No. 2						See Navajo and Swastika. (Hulin 25:139; Tucker 30:281; 31:354.)
318	Humbug	Mrs. J.R. Lane, Yermo	10	10N	1E	SB	Calico district. Calic-Odessa group. Adjacent to Bismarck which see in discussion of east group herein. (Crawford 96:607; Irelan 88:497; Lindgren 87:723-726, pl. 6; Storms 93:338,344.)
	Ivanpah mines	Various undetermined owners	24 (?)	17N	13E	SB	Northeast Clark Mt. area, old Ivanpah district. High grade silver-gold ores shipped to South Wales, and milled at the old town of Ivanpah from various mines in the vicinity. Active from 1865 to 1881. Long idle. (De Groot 90:531; Crawford 94:376.)
	Johannesburg Mining and Milling Co.						See Silver Glance, Silver King, Silver Moon.
319	Kelly (California Rand)	Frank Royer, Red Mountain	6	30S	41E	MD	In Red Mountain, Randsburg area. (Carpenter 19:940-947; Hulin 25:92-107,110-121; 23:407-411; Newman 23:61; 23:98-99; Stewart 50:344-345; Tucker 21:361-362; 23:167; 24:48-49; 24:96; 30:273-274; 31:345,346; 43:483; herein.)

SILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Kelly Rand Extension		6	30S	41E	MD	Prospect in Randsburg area. Vertical shaft, 625 ft. deep, with 80 ft. of crosscuts at 600 ft. level. No ore encountered. (Hulin 25:136; Newman 23:104; Tucker 30:279; 31:351.)
320	Lamar	J. Mulcahy, 998 14th St., San Bernardino	16,17	10N	1E	SB	Calico district. Adjacent to Waterloo. See in discussion of west group herein.
321	Langtry	H. Britt and Walter Alf, Daggett	7,8	10N	1E	SB	Calico district. See in discussion of west group herein. (Crawford 96:607; Storms 93:338,343.)
322	Leviathon	H. Britt, Daggett	8,9	10N	1E	SB	Calico district northwest end. Series of parallel veins up to 50 ft. wide in zone several hundred feet wide, traceable over 2000 ft. along strike on surface. Silver in barite-jasper gangue, with abundant iron oxides. Large tonnage of barite visible. Explored by 4 adit levels having 1500 ft. of workings and two winzes, and by shafts over 100 ft. deep having stopes open to the surface. Production undetermined. Long idle.
	Little Jack		7	30S	41E	MD	Prospect in Randsburg area. (Hulin 25:144; Tucker 30:279; 31:352.)
	Lode Star						See Lone Star.
323	Lone Star (Lode Star)	J.B. Mulcahy, 998 14th St., San Bernardino	15	10N	1E	SB	Calico district. One of mines in upper Wall Street Canyon. (Tucker 21:pl.6.)
324	Lucky Jim	Mrs. James Menter, P. O. Box 892, Hollywood	30 25	6N 6N	18E 17E	SB SB	East slope Old Woman Mts. Quartz vein 4 ft. wide, in granite contains chlorides and bromides of silver, chalcopyrite and small amounts of argentite and ruby silver. Developed by over 1200 ft. of workings including a 200-ft. shaft, 500 ft. cross-cut and over 300 ft. of drifts. Reported $35,000 production when mine was active from

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
324	Lucky Jim (continued)						1911 to 1930. Selected ore reported to carry from 200 to 400 ozs. of silver, $3 to $4 in gold, 5 percent copper and 5 percent lead. Ore shoot 75 ft. wide, 100 ft. long. Idle. (Eric 48:310; Tucker 30:215-216, 279-280; 31:274-275; 43:pl.7.)
	McShane	Undetermined		10N	1E	SB	Calico district. Three miles west of Waterloo mine. Vein is reported to be 7 to 8 ft. wide, traceable for 700 ft. on the surface and carry $24 to $800 per ton in silver. (Irelan 88:499.)
325	Mizpah Montana	Mizpah Montana Mining Co., Inc. (1925)	6	30S	41E	MD	Randsburg area. Vertical shaft. 700 ft. deep, 7 levels, 1300 ft. of workings along contact between Rand schist and quartz monzonite. Small stock-work of veins yielded ore said to average $20 gold and 100 oz. silver per ton. (Hulin 25:138; Tucker 23:167-168; 29:57-58; 31:352-353.)
	Mojave Rand			29S	41E	MD	Prospect in Randsburg area. (Hulin 25:144; Newman 23:104.)
	Mollusk (Cambria, Mescal)						See under gold.
	Mulcahy	J.B. Mulcahy, 998 14th St., San Bernardino		10N	1E	SB	East Calico district. Located 1925. Prospected by Empire Lead Co. shortly after. Idle since 1934 when 200 tons of ore shipped to A.S. & R. at Murray, Utah. Oxidized lead and silver ore in siliceous gangue in breccia zones range from 10 to 30 ft. in width and 30 to 150 ft. in length. Developed by 50-ft. and 150-ft. adits plus several open cuts and pits.
326	Navajo and Swastika (Grady No. 1 and No. 2)	Undetermined	7	30S	41E	MD	Two vertical shafts in Randsburg area. Sunk through Rosamond sandstone into Rand schist. Swastika shaft more than 500 ft. deep. Navajo shaft 1130 feet deep; 1050 ft. drift north on vein which is 2 to 10 ft. wide and assays 2 to 10 ozs. of silver per ton. Vein explored. No ore shipped.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
326	Navajo and Swastika (Grady No. 1 and No. 2) (continued)						(Hulin 25:139; Tucker 30:281; 31:354.)
327	Occidental	Mrs. J.R. Lane, Yermo	10,15	10N	1E	SB	Calico district. Part of Calico-Odessa group. Occidental group included Argonaut, Bismarck, Cleveland, Garfield, Invincible, Runover, Thunderer and Veto claims. See Garfield, in east group discussion. (Crawford 96:608; Goodyear 88:511; Irelan 88:497; Storms 93:344.)
328	Odessa	Mrs. J.R. Lane, Yermo	14	10N	1E	SB	Calico district. Part of Calico-Odessa group and described in east group discussion herein. (Crawford 96:608; Lindgren 87:pl. 6; Storms 93:338,343,344; Tucker 21:363; pl.6; 30:271-272; 31:344-345; 40:243-244; 43:477.)
329	Oriental	Zenda Gold Mining Co., W.F. Staunton, pres., 1253 Pacific Mutual Bldg., Los Angeles	15	10N	1E	SB	Calico district. Silver King-Oriental group. Old Oriental group included Oregon No. 3, Oriental Nos. 1 through 5, Red Cloud, and Wall Street. See under Silver King in central group discussion herein. (Crawford 96:608; Goodyear 88:509-511; Irelan 88:497; Storms 93:344.)
	Pittsburgh and Mt. Shasta	George H. Clapp, Sewickley, Penn.					Randsburg area. See Black Hawk under gold. Workings driven in unsuccessful search for extension of rich silver zone of Kelly mine. (Newman 23:105.)
330	Possibility (Prosperity)	L. Coke, Yermo and J.B. Mulcahy, 998 14th St., San Bernardino	17	10N	1E	SB	Calico district. Adjacent to Waterloo, which see in west group discussion herein.
	Prosperity						Calico district. See Possibility.
	Rand Contact		7	30S	41E	MD	Prospect in Randsburg area. Vertical shaft 100 ft. deep, 210-ft. southward drift. Unsuccessful attempt to reach contact between quartz monzonite and Rand schist. (Hulin

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Rand Contact (continued)						25:140; Tucker 23:168; 30:282; 31:355.)
	Red Cloud	Zenda Gold Mining Co., W.F. Staunton, pres., 1253 Pacific Mutual Bldg., Los Angeles	15	10N	1E	SB	Calico district. Part of Silver King-Oriental group. See under Silver King in central group discussion herein. (Erwin 40:301; Irelan 88:497; Lindgren 87:722,pl.6; Tucker 21:pl.6; 30:289, claim map, opp. p. 270; 31:362, claim map, opp. p. 344.)
	Red Jacket	Zenda Gold Mining Co., W.F. Staunton, pres., 1253 Pacific Mutual Bldg., Los Angeles	15	10N	1E	SB	Calico district. Part of Silver King-Oriental group. See under Silver King in central group discussion herein. (Erwin 40:301; Irelan 88:498; Lindgren 87:722; pl. 6; Storms 93:345; Tucker 21:pl.6; claim map opp. p. 270; 31: claim map opp. p. 344.)
	Revier						See Galena King.
331	Riggs	W.B. Turner, Long Beach (1943)	2	16N	8E	SB	Western Silurian Mts. north of Baker, but commonly incorrectly called Alta mine in previous descriptions. Native silver, galena, cerussite, and chlorobromides of silver in irregular lenses, up to 4 ft. wide, along a series of parallel faults and fissures in limestone. Developed by 3 adits, 150,165, and 25 ft. long with 280 ft. of drifts as well as a 1700 ft. cross cut reported to intersect ore assaying 11 percent lead, 5 ozs. silver. Most recent production 1931. 200,000 ozs. Ag produced to 1920; ore had some gold,lead, and copper. Long idle. (Eric 48:297; Tucker 21:359; 30:267; 31:340; 43:474, pl.7.)
	Runover Co.						Calico district. Former operator of large number of mines in east Calico, including Garfield, Thunderer, Mammoth, Occidental, Oriental, Red Cloud, Wall Street, and Silver Monument, which see in discussion of east group herein. (Bradley 30:55; Irelan 88:497.)
	St. Louis						See Consolidated.

SILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
332	Santa Fe (Wortley Consolidated Mines Co.)	Worley Consolidated Mines Co., San Fernando (1943)	6	30S	41E	MD	Randsburg area. Two vertical shafts; the Santa Fe 1230 ft. deep, and the Silver Queen 1200 ft. deep passed from Rosamond sandstone into Rand schist at 850 ft. Levels at 935,1000,1100 and 1200 ft. totaled 7575 ft. in 1930. Encountered Antimony and Schist veins. Schist vein reported to average 19.36 oz. silver and 0.13 oz. gold per ton. Active in the period 1927-1937. (Hulin 25:134; Tucker 30:282,287-288; 31:355,360-361; 43:487, pl.7.)
333	Silver Bell (Silver Belle)	Silver Bell Mining Co. (1925)	6	30S	41E	MD	Randsburg area. Vertical shaft 700 ft. deep; workings on 500- and 700-ft. levels total over 700 ft. in length. All workings in Rand schist. Several siliceous veins encountered. (Hulin 25:141; Tucker 23:169; 30:283; 31:356.)
	Silver Belle						See Silver Bell.
334	Silver Bow	J.F. Reber, 3125 Arrowhead Ave., San Bernardino	9	10N	1E	SB	Calico district, northwest end, adjoining Leviathon mine. Moderately dipping vein 3 ft. wide carries silver-lead ore in barite gangue; faulted off at lower levels. Explored by 230-ft. inclined shaft (50^{o}) and 500 ft. of drifting. Several carloads of ore, from exploration work prior to 1925, reported to average 100 ozs. of silver per ton. Production undetermined. Idle.
335	Silver Contact	B.F. Houges, Yermo	9	10N	1E	SB	Calico district, northwest end. Barite vein in tuffaceous andesite flows near agglomerate neck. Exposed by steeply inclined shaft more than 150 ft. deep. Second shaft 200 yds. north inclined 55^{o} for 65 ft. Follows bedding in tuff. Production undetermined. Idle.
	Silver Giant	Silver Giant Mining Co. (1925)	32	29S	41E	MD	Randsburg area. Vertical prospect shaft, 80 ft. deep, in Tertiary sedimentary rocks. No ore encountered. (Hulin 25:141-142; Tucker 30: 284; 31:357.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
336	Silver Glance	Johannesburg Mining & Milling Co.	6	30S	41E	MD	Randsburg area. Vertical shaft, more than 500 ft. deep, passes through Tertiary sandstone into Rand schist. (Hulin 25:142; Tucker 23:169; 30:284; 31:357.)
	Silver Hills						See Annex.
337	Silver King (Johannesburg Mining and Milling Co.)	Johannesburg Mining and Milling Co. (1925)	6	30S	41E	MD	Randsburg area. Vertical shaft, 700 ft. deep passes through Tertiary sandstone into Rand schist. Levels at 600,650, and 700 ft; workings (mostly drifts) total more than 1000 ft. and follow 4 veins. First shipment averaged $7.30 gold, 95 oz. silver. (Hulin 25:142; Newman 23:61-62; Tucker 23:169; 30:278,284; 31:351, 357.)
338	Silver King (Silver King-Oriental)	Zenda Gold Mining Co., W.F. Staunton, pres., 1253 Pacific Mutual Bldg., Los Angeles; leased to John Coke, Calico (1943)	15,22	10N	1E	SB	Calico district. Silver King-Oriental property includes Burning Moscow, Joseph, Oregon, Oriental, Red Cloud, and Red Jacket claims. See central group discussion herein. (Crawford 94:376; 96:608; Erwin 40:301; Goodyear 88:509-511; Irelan 88:498,510,512; Lindgren 87:721-723; Storms 93:339-343; Tucker 21:363-364,365,pl.6; 30:289-291; 31:362-364; 43:491-492, pl. 7.)
	Silver King - Oriental						Calico district. See Silver King.
339	Silver Moon	Johannesburg Mining and Milling Co. (1925)	6	30S	41E	MD	Randsburg area. Vertical shaft, 550 ft. deep in Rand schist. Levels at 200,300 and 550 ft.; workings total about 1300 ft. and explore at least 2 veins. Ore generally low grade. (Hulin 25:142; Newman 23:61,62; Tucker 30:278,284; 31:351-357.)
340	Silver Monument	Zenda Gold Mining Co., W.F. Staunton, pres., 1253 Pacific Mutual Bldg., Los Angeles	22	10N	1E	SB	Calico district, Silver King group. Silver minerals disseminated in white, ashy rhyolite tuff. Mined by open pit methods to depth of 65 ft. Started in 1887 but inactive by 1896 after producing large amounts of ore. Long idle. (Crawford 96:609; Irelan 88:497; Lindgren 87:pl.6.)

SILVER (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Silver Reef						See Akron-Silver Reef.
	Silverado						Ivanpah Mts. See under tungsten. Produced small amount of silver ore prior to 1900.
	Sioux (Sue)						Calico district, Wall Street Canyon group. See Falls in central group discussion herein. (Irelan 88:449; Lindgren 87:pl.6; Tucker 21:pl.6; 30:claim map, opp. p. 344.)
	Sue (Sioux)						Calico district. Wall Street Canyon group. See Falls in central group discussion herein. (Lindgren 87:pl.6; Tucker 21:pl.6; 30:claim map opp. p.270; 31:claim map opp. p. 344.)
341	Teutonia	Undetermined	11	14N	13E	SB	Southern Ivanpah Mts. According to local residents, two vertical shafts, 200 and 40 ft. deep, the deeper now flooded below 80 ft. level. Production undetermined. Long idle.
	Thunderer						Calico district. Part of Calico-Odessa group. See Garfield in east group discussion herein. (Erwin 40:243; Irelan 88:497; Tucker 43:477, pl.7.)
	Tip Top						Lava Beds district. Discovered in 1890; high-grade free-milling silver ores, carrying an average of 30 ozs. of silver per ton, were mined from an oxidized zone in which native sulfur and iron oxides were associated. Below depth of 80 ft. silver decreased but pockets of high-grade copper ores were found and mined. See under copper. (Crawford 96:61; Eric 48:318; Storms 93:354-358; Tucker 30:285; 31:358.)
	Total Wreck						Calico district. See Burcham. (Erwin 40:302-303; Lindgren 87:727; Tucker 21:351; 30:285-286; 31:358-359; 40:59-61,

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Total Wreck (continued)						242-243; 43:475-476.)
342	Union	Union Mining Co., Jack Moore, pres., Yermo	16	10N	1E	SB	Calico district. See west group discussion herein. (Erwin 40:303; Tucker 40:246; 43:489, pl.7.)
343	Voca	Undetermined	16	10N	1E	SB	West Calico district, adjacent to Waterloo mine, which see in west group discussion herein. (Irelan 88:495,498.)
344	Waterloo	Waterloo Mining Co., J.T. Weakely, pres., Anaheim	16,21	10N	1E	SB	Calico district. See west group discussion herein. (Bradley 30:55; Crawford 94:376; 96:609; Erwin 40:303; Irelan 88:492-495,498,499; Lindgren 87:728; Storms 93:338,343, 345; Tucker 21:pl.6; 30:286-287; 31:359-360; 40:246-247; 43:489-490, fig. 13.)
345	Waterman	R.W. Waterman, P.O. Box 15, Daggett	18 13	10N 10N	1W 2W	SB SB	North of Barstow, west of Calico district. (Bradley 30:55; Crawford 96:609; Crossman 90:238; De Groot 90:531; Newman 23:542; Tucker 30:287,299; 31:360,373; 40:250; herein in silver section under "Mines in other areas".)
	Wall Street Canyon		15	10N	1E	SB	Calico district. Several mines and claims northwest of Calico townsite on west cliffs of Wall Street Canyon, including Consolidated, Consolidated Extension (St. Louis), Elizabeth, Falls (Sioux, Sue), Jessie, Little Waterman, Lone (Lode) Star, Wishing Well (Governor Smith), and Young Waterman claims. (Lindgren 87:pl.6; Tucker 21: pl. 6; 30: claim map, opp. p. 270; 31:claim map, opp. p. 344.)
	Wortley Consolidated Mines Co.						See Santa Fe.
	Zenda Gold Mining Co.						Calico district. Owners of Silver King-Oriental mine. (Tucker 30:289-291, claim map opp. p. 270; 31:362-364, claim map opp. p. 344; 40:247-248; 43:491-492, pl.7.)

TIN

MAP NO	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Apex	Dutton and Hammond, Cima	25	15N	13E	SB	Southwestern Ivanpah Mts. Tin ore in small kidneys in talcose zone in dolomitic limestone. Explored by [illegible]5-ft. shaft; 20-lb. sample carried 5% tin. ([illegible]erstrom 41:551.)
	Evening Star						Western foothills of Ivanpah Mts. See under tungsten. Small production of tin ore in 1942-44. Property also explored for copper and has produced tungsten ore. (Tucker 43:498-499.)

TITANIUM

MAP NO	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Johnson and Vogt Rutile deposit	H.R. Johnson, Lenwood and A. Vogt, Daggett (1943)	21	9N	3W	SB	North of Hodge. Small pink crystals of rutile disseminated, but with local banded concentrations, along 200 ft. of an irregular. lenticular body of quartz in schist. Quartz 1500-ft. long, 75-ft. max. width. Explored by few shallow cuts. No production.

MAP NO	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Acley						See Atolia. (Hulin 25:126; Jenkins 42:346; Lemmon 40:236, 237.)
	Adelanto Mining Company	Adelanto Mining Co., Inc., Nicholas Baxter, pres., Box 275, Adelanto	30,31	8N	6W	SB	Shadow Mts. Part of "North" tungsten field. Scheelite disseminated in tactite formed along beds in limestone interbedded with schist. Numerous open cuts, trenches and shallow shafts on several claims. Mary Ann claim in sec. 31 now being worked by lessee. See Mary Ann.
346	American Gold and Tungsten (Top Notch)	American Gold and Tungsten Corp.	19	30S	41E	MD	North of Union mine, Atolia district. Top Notch claim has yielded small tonnage of tungsten ore. (Jenkins 42:346; Lemmon 40:244; Partridge 41:284; Tucker 43:pl.7.)
	American Tungsten Mining and Refining Company						See Garvanza.
	Amity						See Atolia. (Hulin 25:126; Jenkins 42:356.)
	Antelope	L.Z. Bess, 890 Campus Way, San Bernardino, and Fuller Arthrup, Banning	33	2N	3E	SB	East end San Bernardino Mts. (Tucker 43:499, pl.7.)
	Argosy						See Old Glory. (Cloudman 19:844-845; Partridge 41:3[illegible]-3[illegible]; Tucker 30:291; 31:364; 43:499, pl.7.)
347	Atolia (Following mines now operated by Surcease Mining Co. formerly operated by Atolia Mining Co: Acaley, Amity, Attila, Flat Iron, Goldstone, Mahood, Papoose, Par, Paradox 1 and 3,	Atolia Mining Co., 1022 Crocker Bldg., San Francisco. Leased to Surcease Mining Co., Sacramento	19,20	30S	41E	MD	Atolia district. (Boalich 18:12; Cloudman 1[illegible]:[illegible]3[illegible]-[illegible]37. Hess 17:40,44-45; Hewett 36:90; Hulin 25:7[illegible]-7[illegible],1[illegible]5-1[illegible]; Kerr 46:61-62,69,148-151; Lemmon 40; Partridge 41:[illegible]52-257, 264-266, 276,278,283,284-285; Tucker 21:37[illegible]-37[illegible]; 24:96-97; 30:291-293; 31:365-366; 40:12, 55; 43:49[illegible],5[illegible], pl. 7; herein.)

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
347	Atolia (continued) Rainstorm, Spanish, Spud Patch Placers, and Union)						
	Atolia Mining Company						See Atolia.
348	Atolia - Rand Placers (Nieto Placer group, Redondo Pete)	Pacific Scheelite Corp. controlled by Molybdenum Corp. of America, New York (1940)	19,30	30S	41E	MD	Atolia district. Redondo Pete claim operated 1917-19 by Black Hawk Mining Co. Sank 500-ft. vertical shaft, levels at 300 and 500 ft. Small production. Placer property operated 1934-36 using 1500-cu. yd. concentrating plant. (Jenkins 42:348; Laizure 34:246; Lemmon 40:242; Partridge 41:285; Tucker 40:55-56; 43, pl.7.)
	Atolia Tung-Sun Placer Mining Company	Lessee (1943): Ray Schwietzer, 5633 Lexington Ave., Los Angeles.	7	30S	41E	MD	Baltic Gulch 2 miles south of Randsburg. Placer property. (Tucker 43:500, pl.7.)
	Attila						See Atolia. (Hulin 25:126; Jenkins 42:346.)
	Beacon						See Bonanza Dome and Beacon.
	Bernice						See Evening Star. (Jenkins 42:349; Kerr 46:164; Tucker 43:130-131; 43:498-499.)
	Big Ben						See Osdick group. (Lemmon 40:240-241.)
349	Black Hawk (Leonard and Halloran)	Black Hawk Tungsten Mines Corp., M.L. Conroy, 527 Front St., San Pedro (1941)	19,20, 29,30	30S	41E	MD	Atolia district. Scheelite in quartz veins, also gold. Tungsten production small. Developed by 4 shafts, deepest 140 ft. (Cloudman 19:837; Jenkins 42:348; Lemmon 40:243; Partridge 41:285-286; Tucker 21:372-373; 30:293; 31:366-367; 43:pl. 7.)
	Black Mountain						See under copper. Tungsten discovery recently reported.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Blue Grass						See Riley. (Kerr 46:164.)
350	Blue Vase	William Baur, Los Angeles (1941)	2	2N	3E	SB	Eastern slope San Bernardino Mts. Scheelite in narrow quartz veins along zone about 40 feet wide. Developed by 2 open cuts and 2 shafts about 20 ft. deep. (Jenkins 42:352; Tucker 41:584; 43:500-501; pl.7.)
351	Bonanza Dome and Beacon	Norris Williams, Apple Valley	30	7N	6W	SB	Shadow Mts. Part of "South" tungsten field. Scheelite in tactite developed in marble and schist near contact with gneissoid granite. Also scheelite coating on large calcite crystals. Operated May 1942 to March 1943 by Mine Development Co., H.S. West, pres., Pasadena. Produced between 500 and 600 tons of ore which yielded more than 225 units of WO_3. Bonanza Dome developed by 55-ft. shaft with 20-ft. winze below 55-ft. level workings. Beacon claim, $\frac{1}{2}$ mile northeast, developed by 2 shallow shafts and 2 pits, 8ft. max. depth. Idle. (Jenkins 42:351; Kerr 46:164; Partridge 41:316-317; Tucker 40:59; 43:501, pl.7.)
352	Bright Outlook	Harry F. Heather, 236 So. Oak Knoll Ave., Pasadena	32	13N	13E	SB	East of Marl Spring. Scheelite in tactite developed near contact between Archean metamorphic rocks and granitic rock. Prospected by several pits.
353	Bronze (Live Oak)	D.A. Dobbins and associates, 1106 W. Isabel St., Burbank	29	14N	16E	SB	South part New York Mts. Tungsten (scheelite and ferberite) silver-zinc mineralized zone, 5 to 7 feet wide, in Goodsprings dolomite near contact with quartz monzonite; abundant fluorite. Explored by northwest-trending acit, 300 ft. long, small stopes, and 50-foot winze. First worked in early 1900's. Reopened 1950 when mill constructed near Barnwell townsite. Only production small shipment of concentrates 1951. (Jenkins 42:350.)
	Brooke Molybdenite and Tungsten						See Big Hunch under Molybdenum. (Jenkins 42:349; Tucker 41:584; 43:501.)

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Brooke Molybdenite and Tungsten						See Big Hunch under Molybdenum. (Jenkins 42:349; Tucker 41:584; 43:501.)
	Buckeye	Buckeye Tungsten Co., C.C. Ray, Atolia (1941)	18	30S	41E	MD	Atolia district. Three parallel scheelite-bearing quartz-calcite veins in quartz monzonite. Veins about 50 ft. apart and 2 in. to 2 ft. wide. Two 50-ft. shafts on middle vein. Small production in 1918. (Jenkins 42:345; Partridge 41:286; Tucker 21:373; 30:294; 31:367.)
	Carbonate						See Garvanza. (Boalich 18:12; Cloudman 19:841; Partridge 41:306; Tucker 21:373; 30:294; 31:367.)
	California Vanadium Company						See Lombard and Main group. (Cloudman 19:845-846,849-850.)
354	Celestial	Walter F. Mercier, and assoc. 7349 Tampa Ave., Reseda	4,9	12N	2E	SB	Small hills east of Paradise Range. (Herein.)
	Chubbuck Scheelite						See Udsogn.
355	Clipper Mountains	Oscar Hoerner and assoc., Newberry, and Ralph W. Ross, 710½ Park Ave., South Pasadena	14,23	8N	15E	SB	Clipper Mountains northwest of Essex. (Herein.)
356	Columbia	Frank Curtis, Death Valley Inn, and Jerry Korfist, Box 75, Baker	10	17N	13E	SB	North Clark Mountain area. Scheelite and wolframite with quartz veins and rhyolitic dike near schist-granite contact. Being explored and developed on small scale in early 1952.
357	Confidence Copper	Edward Bluett, Kelso (1916)	5	11N	14E	SB	Southwest slope Providence Mts. Also copper. Wolframite with chalcopyrite in quartz veins. Small production 1918.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T	R.	B & M	REMARKS
357	Confidence Copper (continued)						(Boalich 18:12; Cloudman 19:848-849; Eric 48:302; Jenkins 42:35; Kerr 46:164; Partridge 41:306; Tucker 21:340; 30:209; 31:269.)
	Copper King	J. Riley Bembry, Cima	25	15N	13E	SB	Ivanpah Mts. Near Evening Star, which see herein. Tungsten prospect in small tactite zone. Numerous shallow workings in addition to one 225-ft. inclined shaft. See under copper.
	Copper Queen						See under copper.
	Desert Mining Company	A.B. Carpenter, Los Angeles (1918)		Approx. 11N	13E	SB proj.	Northwestern slope of Providence Mts. Wolframite in quartz veins in granite. Small production 1918. (Boalich 18:12; Cloudman 19:848-849.)
	Desert Tungsten	Monarch Rand Mines Co. leased 1943 to W. DeWitt, Randsburg	7	30S	41E	MD	Placer property in Baltic Gulch. (Tucker 43:130.)
	Dorr						See Lighthouse. (Jenkins 42:350; Tucker 41:584-585; 43:501-502, pl.7.)
	El Mirage district						Tungsten district in Shadow Mts. also referred to as "South" field. Initial tungsten discovery made in this area in 1937 by Nicholas Baxter. See Bonanza Dome and Beacon, El Mirage Mine, New Discovery. Many other prospects. (Kerr 46:163.)
	El Mirage Mine	Mines Development Co., Pasadena	32	7N	6W	SB	Shadow Mts. district. South field. (Jenkins 42:351.)
	Elkhorn Mining Company						See Gold Basin. (Tucker 30:233; 31:293-294.)

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
358	Evening Star (Bernice, Rex)	C.F. Wendrick, Jr., Steel Service & Sales Co., 53 W. Jackson Blvd., Chicago, Ill. C.L. Haythorne, Nipton, Operator.	24, 25(?)	15N	13E	SB	West slope Ivanpah Mts. (Tucker 43:130-131; 43:498-499, pl. 7; herein.)
	Excelsior						See Riley. (Eric 48:305.)
359	Rederal Company's group (Raynor group)	J.C. Raynor, N.H. Meyers, G.T. Ingram, Atolia	19, 20	30S	41E	MD	Atolia district. Several scheelite-bearing carbonate-quartz veins in quartz monzonite. Known ore bodies appear faulted off within 40 ft. of surface. Two unconnected shafts 83 ft. apart. Several 100 ft. of drifts in west shaft. Deepest shaft 242 ft. on incline. Reported production $30,000 through 1930. (Jenkins 42:348; Lemmon 40:241-242; Partridge 41:286-287; Tucker 30:294; 31:367.)
	Flat Iron						See Atolia. (Hulin 25:127; Jenkins 42:346; Lemmon 40:238-239.)
	Four Brothers (Whatnot)	Joseph Scheerer, Victorville (1916)	3	6N	4W	SB	Silver Mountains district northeast of Victorville. Formerly gold property. Scheelite in quartz vein in granite. No tungsten production. (Cloudman 19:815,849; Crawford 96:329; Crossman 90:228; Jenkins 42:352; Kerr 46:164; Partridge 41:316.)
	Francis Copper						See under copper. (Jenkins 42:351; Kerr 46:164.)
360	Garvanza (American Tungsten Mining and Refining Co., Carbonate)	J.W. Morrison, Ivanpah (1941)	23	14N	15E	SB	West part of New York Mts. Wolframite in narrow quartz veins in pegmatite dike. Small production in 1916. Two adits 260 ft. and 240 ft. long; one about 80 ft. above the other; connected by raise. Fifty-foot winze in lower tunnel. (Boalich 18:12; Cloudman 19:841; Partridge 41:316; Tucker 21:373; 3[illegible]:294; 31:367.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Giant Ledge						See under copper.
361	Gillsmith and Victory	H.S. Gillies 3650 Revere Ave., Los Angeles (1943)	17	14N	16E	SB	Northwest slope New York Mts. Scheelite with quartz and fluorite on granite-limestone contact. (Jenkins 42:350; Tucker 41:585; 43:502, pl.7.)
	Gold Basin (Elkhorn Mining Co., Golden Era, Silver Basin)	Gold Basin Mines, Clarence Barker, Los Angeles	7	30S	41E	MD	Red Mountain area. Two parallel scheelite- and gold-bearing quartz veins in Rand schist. Formerly worked only for gold. Mined from 240-ft. and 200-ft. shafts. (Hulin 25:141; Jenkins 42:345; Tucker 23:63,169; 30:233; 31:293-294; 43:502, pl.7.)
362	Gold Divide	Mrs. Ray Wolfe, 3819 E. 54th St., Maywood	1, 12	13N	1E	SB	Goldstone district. Five parallel quartz veins near schist-limestone contact. Contain scheelite and gold; 12 in. to 2 ft. wide. Shafts 85 ft., 107 ft., and 100 ft. deep. Several tons of tungsten ore shipped in 1951. Formerly mined only for gold. (Tucker 40:65-66; 43:451; pl.7.)
	Golden Era						See Gold Basin.
	Goldstone						See Atolia. (Hulin 25:127; Jenkins 42:346; Lemmon 40:237.)
	Green						See Mojave tungsten.
	Guadalupe	Undetermined					"About 4 miles from Manvel". Some ore reported to assay 60% WO_3. (Aubury 06:355; Partridge 41:316.)
	Gustav group	Undetermined	20	30S	41E	MD	Atolia district. Scheelite in placer and veins. Small production 1916. (Cloudman 19:837; Partridge 41:287; Tucker 30:294; 31:367.)
	Gypsy group (White Flower)	A. Nixon, Randsburg (1917)	20	30S	41E	MD	Atolia district. Scheelite. High grade ore mined 1917. (Boalich 18:13; Cloudman 19:839; Jenkins 42:347; Partridge 41:287.)

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
363	Hidden Value (Hidden Value and Victory)	L.J. Rouchleau, 2700 Budlong Avenue and Mrs. M.M. Richardson, Los Angeles	6,8	5N	17E	SB	Old Woman Mts. (Jenkins 42:352; Kerr 46:165; Tucker 43: 502-503; pl. 7; herein.)
	Hidden Value and Victory						See Hidden Value.
	Hoeffling Brothers						See Atolia.
	Holliday						See under gold.
	Hollie-Ann						See under gold.
364	Howe (Section 9)	Walter Zindell, Essex	9	5N	17E	SB	In Old Woman Mts. (Tucker 43:503-504, pl. 7; herein.)
	Irish (Lord and Irish)	Joseph Lord and A.A. Irish, Los Angeles (1919)		Approx. 8N	18E	SB	10 miles south of Goffs. Wolframite in quartz. (Boalich 18:12,13; Cloudman 19:846-847; Tucker 30:294; 31:367.)
	Jack	John H. Williams (1917)					Clark Mts. near Nipton. Wolframite. (Hess 17:47, pl. 5; Williams 11:545.)
	Jacobs						See Old Glory. (Boalich 18:13.)
	Jersey Lily	Rare Metals Refining Co. (1918)	6, 7	30S	41E	MD	In Red Mountain area. Scheelite in narrow veins. Small production 1917-18. (Hulin 25:72,144; Jenkins 42:345; Partridge 41:288.)
365	Jumbo Tungsten	Bert Craig, P.O. Box 6, Essex	28	6N	17E	SB	Old Woman Mts. Scheelite in tactite. Owner reports 50 tons ore produced 1950. Idle.
	Just Associates						See Just Tungsten Quarries.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
366	Just Tungsten Quarries (Just Associates, Princess Pat, Shadow Mountain Mines)	Just Associates, 726 Story Bldg., Los Angeles	30, 31, 32	8N	6W	SB	Shadow Mts. "North" tungsten field. (Jenkins 42:351; Kerr 46:164; Partridge 41:250,316-317; Tucker 40:78; 43:505, pl.7; herein.)
	Keystone						See under gold. "Ferberite (?) in Tertiary volcanics". (Jenkins 42:351; Kerr 46:165.)
	Kinsman	J.C. & W.O. Kinsman, Goffs (1916)		Approx 11N	17E	SB	"8 miles north of Goffs". Probably wolframite. (Boalich 18:13; Cloudman 19:845; Partridge 41:306.)
	Leonard and Halloran						See Black Hawk. Scheelite in placer and lode. (Cloudman 19:837.)
367	Lighthouse (Dorr)	Jack Licht, Jaylite Mining and Milling Corp., Box 306, Barstow	25,36	14N	15E	SB	South end New York Mts. Wolframite associated with quartz in steeply dipping pegmatite dike cutting granodiorite. Explored by 140-ft. inclined shaft with short workings on 40- and 140-ft. levels, an adit driven to intersect the 140 ft. level, and an open cut just north of the shaft. About 1500 tons of ore mined during short period 1950-51 to be hauled to mill at Barstow, but grade of ore proved uneconomical. (Jenkins 42:350; Tucker 41:584-585; 43:501-502, pl.7.)
	Lineberger	Walter F. Lineberger. Leased to Walter W. Hartman, 1230 E. 109th St., Los Angeles		15N	14E	SB	In Ivanpah Mts. Tactite zone with small amounts of scheelite.
	Live Oak						See Bronze. (Jenkins 42:350.)
	Livingstone						See Sunnyside.
	Log Cabin						See under gold.

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Lombard and Main group (California Vanadium Co.)	A.L. Lombard, J.F. Main Estate, Goffs, (1941)	20	11N	17E	SB	North of Goffs. Wolframite and vanadium mineral in placer materials and in veins cutting granite. Idle. (Cloudman 19:845,846,849,850; Jenkins 42:351; Partridge 41:307; Tucker 30:294; 31:367.)
	Lord and Irish						See Irish.
368	Lucky Boy	Meredith Brown, 609 N. Friends, Whittier. Leased to Horace A. Lackey, 854 So. Oxford Los Angeles	30	8N	6W	SB	Shadow Mts., "North" tungsten field. Scheelite in tactite along schist and granite contact. Developed by 3 open cuts and a 40-ft. vertical shaft. A few tons of ore shipped from dump in 1938. Being developed 1952.
	Lucky Jim						East slope Old Woman Mts. Tungsten minerals recently reported. See under silver.
	Lucky Lode						See Silver Star.
	Mahood						See Atolia. (Hulin 25:126; Jenkins 42:346.)
	W.H. Mann	W.H. Mann, Randsburg (1929)		30S	41E	MD	Atolia district. Small production 1929. (Partridge 41:288.)
	Marble Canyon	H.S. Hoard, Route 1, Box 381, Upland	17, 18, 19	1N	7W	SB	A prospect reported by owner.
369	Mary Ann	Adelanto Mining Co., Nicholas Baxter, pres., Box 275, Adelanto. Leased to George Kablitz, See Drive at Hadley, Whittier	31	8N	6W	SB	Shadow Mts., "North" tungsten field. (Herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Mathilde	T.W. Craig, Goffs, via Fenner	28 (?)	11N	18E	SB	North of Goffs. Wolframite in narrow, parallel quartz veins in granite; strike east, dip 60° N. Explored by several shallow shafts. Idle.
	May Day						See White Dollar. (Tucker 43:504,po.7.)
	Mine Development Company						See Bonanza Dome and Beacon. (Tucker 43:133.)
	Mojave Annex	Mojave Annex Tungsten Co., J.B. Evans, president, Los Angeles (1916)	23	14N	15E	SB	North slope New York Mts. Wolframite in quartz stringers in pegmatite dike. Produced in 1916-17, 1920. (Boalich 18:13; Jenkins 42:349; Partridge 41:307; Tucker 21:373-374; 30:294; 31:367.)
370	Mojave Tungsten (Green)	Colosseum Mining and Smelting Corp., C.H. Gowman, president, 7371 Sunset Blvd., Hollywood (1943)	15	17N	13E	SB	North end Clark Mtn. Scheelite and wolframite in quartz-calcite vein 4 ft. wide and at least 1000 ft. long. Ore in shoots as much as 75 ft. long, reported to carry 0.5 to 5.0% WO_3. Shaft 170 ft. deep with several 100 ft. of drifts. Reported production 60,000 lbs. 60% concentrates 1915-16. (Cloudman 19:839; Jenkins 42:348; Kerr 46:162; Partridge 41:307-308; Tucker 30:294; 31:368; 43:504-505, pl.7.)
371	Moonlight (Scheelite Queen, Tungsten King)	Raymond Jones, Box 171, Barstow	32, 4	31S 32S	47E 47E	MD MD	Eight miles south of Goldstone. (Herein.)
	Morongo King						See Sunnyside.
	New Discovery	Just Associates, 726 Story Bldg., Los Angeles	30	7N	6W	SB	Shadow Mts. area, South field. Lies between Beacon and Bonanza Dome. Scheelite in tactite. Idle. (Hess 22:261; Jenkins 42:351; Kerr 46:163; Tucker 40:71-72; 43:pl. 7.)
	New York						See Sagamore under copper.
	Nieto Placer group						See Atolia - Rand Placers. (Tucker 30:294-295; 31:368.)

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	OK	D.A. Byers, Barstow and George Michels, 29 Palms	7	7N	2E	SB	In Ord Mts. Scheelite sparsely distributed along vertical shear zone, 3 ft. wide in meta-volcanic rock. Shallow pit.
372	Old Glory (Argosy, C.B. Jacobs deposit)	Mrs. M.E. Remalia, 1912 W. 3rd St., Los Angeles	34 ?	11N	18E	SB	North of Goffs. Small veinlets of hubnerite and wolframite in pegmatite dike. Adit 140 ft. into dike, 38-foot raise to surface. Produced 1916-17. (Boalich 18:13; Cloudman 19:844-845; Partridge 41:305-306; Tucker 30:291; 31:364; 43:499, pl.7.)
373	Osdick group (Big Ben, Skylark)	P.J. Osdick, Red Mountain	20, 21	30S	41E	MD	Atolia district. Scheelite in quartz veins. Skylark on extension of Flatiron vein system and explored to depth of 167 ft. Production of nearly $250,000 from this shaft and adjacent placer deposits 1916-18. Big Ben on extension of Spanish vein system and explored to depth of 187 ft. No production. (Boalich 18:13; Cloudman 19:837-838; Hulin 25:144; Jenkins 42:347; Lemmon 40:240-241; Martin 16:291; Partridge 41:288-289; Tucker 30:295; 31:368; 43:505; pl.7.)
	Pacific Scheelite						See Atolia Rand Placers. (Tucker 40:56.)
374	Packard	Bert Craig, P.O. Box 6, Essex	4	5N	17E	SB	In Old Woman Mts. Epidote-rich tactite developed in limestone and biotite schist. (both Archean.) Scheelite-bearing zone in tactite 6 to 8 ft. wide, exposed on surface for 100 ft. by shallow cuts; dips 55° NW. into steep hillside. Prospect being developed in mid-1952.
	Papoose						See Atolia. Scene of first discovery in the district. Was the leading scheelite-producing mine in the world from 1908-11. (Hulin 25:126; Jenkins 42:346; Lemmon 40:238.)
	Par						See Atolia. (Hulin 25:127; Jenkins 42:346; Lemmon 40:238-239.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Paradise Mountains	P.R. Hetherington, Los Angeles	6, 7	12N	2E	SB	South side of Paradise Mts. Scheelite-bearing tactite body, 4 ft. wide, on granite-dolomite contact. Several open cuts and a 10-foot shaft. A prospect. (Jenkins 42: 350; Kerr 46:165; Tucker 41:585; 43:505, pl.7.)
	Paradox 1 and 3						See Atolia. (Jenkins 42:346; Lemmon 40:239.)
	Pat group	J.L. Strawn and Thompson, Cima	1	11N	14E	SB	In Providence Mts. Wolframite in quartz veins cutting granite. (Jenkins 42:350; Kerr 46:164.)
	Pierce and Creighton	Pierce and Creighton, Los Angeles (1919)					In Providence Mts. Wolframite in quartz veins. (Boalich 18:13; Cloudman 19:848-849.)
	Princess Pat						During late 1940's the Princess Pat Mining Co. leased the property owned by the Just Associates. See Just Tungsten Quarries.
	Prosperity	Undetermined	32	7N	6W	SB	Shadow Mts. tungsten area, "South" field. (Tucker 43: pl. 7.)
375	Pure Quill	G.D. Hedrick, Hesperia, and Leonard Shoush, San Gabriel	4	6N	1E	SB	South part Ord Mts. (Herein.)
	Quirk	Mr. Quirk, Atolia (1916)	17	30S	41E	MD	Atolia district. Scheelite-bearing quartz veins, 4 in. wide, cutting granite; 40-ft. shaft. Small production during World War I. (Cloudman 19:839; Jenkins 42:345; Partridge 41:289.)
	Rainstorm						See Atolia. (Hulin 25:127; Jenkins 42:346; Lemmon 40:236-237.)
	Raynor group						See Federal Company's group.

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Redondo Pete						See Atolia-Rand Placers. (Jenkins 42:345; Lemmon 40:242.)
	Rex						See Evening Star.
	Reynolds Custom Mill	H.I. Reynolds, Boulder, Colorado (1916)					Erected 1916 at Goffs to treat tungsten ores from Signal and New York Mts. district. Dismantled.
376	Riley (Blue Grass, Excelsior, Standard No. 1, Standard Tungsten)	J. Riley Bembry, Cima	18, 19	15N	14E	SB	In Ivanpah Mts. (Eric 48:305,317; Jenkins 42:349; Kerr 46:164; Tucker 41:585-586; 43:505-506, pl.7; herein.)
	Rose Fraction	R. Scott and F. Wiesse (1916)	20	30S	41E	MD	Atolia district. Small production 1916. (Boalich 18:14; Cloudman 19:839; Jenkins 42:347; Partridge 41:289.)
377	Roy Ex	W.H. Schmidt, Box 611 Yucca Valley	28	2N	3E	SB	East end of San Bernardino Mts. Deposit of stream gravel in Rattlesnake Canyon bearing scheelite and gold. Several thousand dollars produced in 1938-1939 according to owner. Idle since.
	Sagamore						See under copper and lead-silver-zinc. Hubnerite in veins with lead and copper minerals. Small tungsten production in 1915. (Cloudman 19:847; Eric 48:316; Jenkins 42:350; Kerr 46:164; Partridge 41:308; Tucker 43:67-68.)
	Scheelite	Mr. Hart, Los Angeles (1916)	21	30S	41E	MD	Eastern part of Atolia district. Scheelite in placer. Small production 1915. (Cloudman 19:839; Jenkins 42:347; Martin 16:295; Partridge 41:290.)
	Scheelite Queen						See Moonlight.
	Section 9						See Howe.
	Shadow Mountains deposits	Various holdings	30, 31,32	8N	6W	SB	Shadow Mts. north of Adelanto. Numerous prospects in area which extends over 6 miles in a southerly direction

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Shadow Mountains deposits (continued)		30,32	7N	6W	SB	from the north slope of Silver Peak. Divided into "North" and "South" fields. Location of many prospects somewhat uncertain. See Adelanto Mining Co., Just Tungsten Quarries, Bonanza Dome and Beacon. (Kerr 46:163-164; Partridge 41:316-317; Tucker 43:pl.7.)
	Shadow Mountains Mines						See Just Tungsten Quarries. (Jenkins 42:351; Kerr 46:164; Tucker 40:78; 43:505, pl.7.)
378	Shafer, Schloerb and Field	R.H. Shafer, E.W. Schloerb, and W.L. Field, Ivanpah (1916)	23	14N	15E	SB	In Cliff Canyon, New York Mts., adjoining Garvanza. Wolframite in quartz veinlets in pegmatite dike. No production. (Cloudman 19:842; Jenkins 42:349; Partridge 41:308.)
379	Shooting Star (United Tungsten Copper Mines)	J.S. Burbridge, 11458 Alber St., North Hollywood, leased to Shooting Star Tungsten Co.	28,29	2N	3E	SB	In Morongo district, east slope San Bernardino Mts. Bismuth carbonate is a reported accessory mineral. (Boalich 18:14; Hess 22:261-262; Jenkins 42:352; Kerr 46:163-164; Partridge 41:246,317; Tucker 21:374; 30:295; 31:368; 43:507, pl.7; herein.)
	Silver Basin						See Gold Basin (Hulin 25:141; Newman 23:63; Tucker 23:169.)
380	Silver Star (Lucky Lode)	Charles H. Richards, 638 Temescal St., Norco, C.E. and H.L. Hammett	7	15N	14E	SB	In Ivanpah Mts. (Jenkins 42:349; Kerr 46:164; Tucker 41:585; 43:505-506, pl.7; herein.)
381	Silverado - Tungstite	J. Riley Bembry, Cima	18	15N	14E	SB	In Ivanpah Mts. Also silver. (Herein.)
	Skylark						See Osdick Group. (Lemmon 40:240, 241.)
	Spanish						See Atolia. (Jenkins 42:346; Lemmon 40:238-239.)
	Spud Patch Placers						See Atolia. (Cloudman 19:837-838; Hess 17:44; Hewett 36:

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Spud Patch Placers (continued)						90; Hulin 25:145; Jenkins 42:348; Kerr 46:69,150; Lemmon 40:225-229; Tucker 43:134-135; 43:506, pl.7.)
	Standard No. 1						See Riley. (Jenkins 42:349; Kerr 46:164.)
	Standard Tungsten						See Riley. (Tucker 41:585-586; 43:506-507, pl.7.)
	Star Dust group	W.W. Woods, 622 W. Valley Blvd., Alhambra (1941)	12	5N	1W	SB	North of Lucerne Valley. A prospect. (Jenkins 42:352; Kerr 46:165; Tucker 41:586.)
382	Starbright	Clair Dunton, 1145 Westminister Ave., Alhambra, and A.C. Lambert, Barstow	19	12N	1E	SB	North of Barstow, 3 miles northeast of Lane Mts. (Herein.)
383	Sunnyside (Livingstone, Morongo King)	G.M. Bussey and E.F. Bain, Whitewater (1943)	27	2N	3E	SB	East slope San Bernardino Mts. Formerly worked for gold and noted in gold section herein. Scheelite discovered in 1941 on Morongo King quartz vein, 800 ft. long and 6 to 8 ft. wide. Contains free gold, pyrite and minor scheelite; on granite-limestone contact. Nearby are 2 scheelite-bearing tactite bodies, 6 to 10 ft. thick, enclosed in granite. Developed by extensions of Morongo King workings and by 2 additional shafts and several open cuts. (Eric 48:317; Jenkins 42:353; Tucker 41:586-587; 43:507, pl.7.)
	Surcease Mining Company						See Atolia.
384	T.P.A. No. 1	W.F. Decter, 5838 Faculty Ave., Bellflower; J.R. Stevenson, La Habra Heights; Bob Mackray and H.J.	11,13, 14	2N	2E	SB	San Bernardino Mts., east of Baldwin Lake. Scheelite with barite in zone, up to 5 ft. wide, between limestone and mica schist. Prospected by trenching along strike for 150 ft.; deepest pit 8 ft. Located late in 1951; no production recorded.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
384	T.P.A. No. 1 (continued)	Kandel, 2409 E. 19th St., Long Beach					
385	Three Trees	W.W. Divine	12	13N	1E	SB	Six miles southeast of Goldstone. Sparsely disseminated scheelite in a thin tactite body on limestone-granite contact. A prospect.
	Toboggan	Elmer Beebe, et al, Atolia	20	30S	41E	MD	Atolia district. Scheelite-bearing quartz veins in quartz monzonite. Small production from shallow workings and placer operation. (Boalich 18:13; Cloudman 19:839; Partridge 41:290-291.)
	Top Notch						See American Gold and Tungsten. (Jenkins 42:346; Lemmon 40:244.)
	Treasure Chest	Norman P. Marsh, 1934 Milan Ave., So. Pasadena (1937)	28	3N	2E	SB	North slope San Bernardino Mts. Tactite containing sparsely disseminated scheelite. Several short adits and shallow shafts.
	Treasury	D.V. McBride, M.H. Elliot, C.W. Peterson (1916)	21	30S	41E	MD	Atolia district. Scheelite in placer. Similar to Spud Patch. Small production in 1916. (Boalich 18:13; Cloudman 19:839; Jenkins 42:347; Partridge 41:291; Tucker 30:295; 31:368.)
	Tungsten						See Moonlight.
	Tungsten King group	J.F. Brooke, F.M. Brooke, F.W. Chausse, and J.G. Bliss, Goffs (1916)	32	14N	15E	SB	South slope of New York Mts. Hubnerite and wolframite irregularly disseminated in pegmatite dike 25 to 60 ft. wide and at least 1200 ft. long. Small production in 1916. (Boalich 18:12; Cloudman 19:842-843; Jenkins 42:349; Partridge 41:251; 308-309; Tucker 30:295; 31:368.)
386	Udsogn (Chubbuck Scheelite)	Lee W. Yim, Amboy	18	4N	17E	SB	Scheelite in tactite zone striking N.75°E. Developed by several open cuts and shallow shafts; 12 tons high grade ore produced 1943.

TUNGSTEN (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Union						See Atolia. (Hulin 25:125-126; Jenkins 42:346; Lemmon 40: 232-235.)
	United Tungsten Copper Mines						See Shooting Star. (Boalich 18:14; Hess 22:261-262; Jenkins 42:352; Kerr 46:163-164; Partridge 41:246,317; Tucker 21:374; 30:295; 31:368; 43:507, pl.7.)
	Victory Tungsten group						See Hidden Value. (Jenkins 42:352; Kerr 46:165; Tucker 43:68-69; 43: pl.7.)
	Weaver Diggings						See under gold.
	Whatnot						See Four Brothers. (Cloudman 19:815,849; Crawford 96:329; Crossman 90:228.)
387	White Dollar (May Day)	J. Ralph McInery, Route 1, Box 314-A, San Bernardino. Leased to Parker Mining and Milling Co., Box 202, Barstow.	7	7N	2E	SB	Ord Mts. (Tucker 43:504, pl.7; herein.)
	White Flower						See Gypsy Group. (Boalich 18:13; Cloudman 19:839.)

TUNGSTEN MILLS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
388	Jaylite	Jaylite Mining and Milling Co., Jack Licht, pres., Box 306, Barstow	5	9N	1W	SB	In east Barstow along the Mojave River. Tungsten custom mill utilizing jaw crusher, ball mill, cone classifiers, concentrating tables and magnetic separators; 100-ton capacity. Rebuilt from burned ruins of mill operated by Pacific Mineral Company, Ltd., for processing roofing granules and barite.
389	Parker Mill	Parker Mining and Milling Co., H.T. and Frank R. Parker, Barstow	36	10N	2W	SB	Northwest of Barstow on the old Waterman Ranch. Custom tungsten mill utilizing jaw crusher, ball mill, jig, cone classifers and concentrating tables.

VANADIUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	California Comstock						See Leiser Ray. (Eric 48:301.)
	California Vanadium Company						See Lombard and Main.
	Gold Park Consolidated Mines						Twentynine Palms district. Vanadinite in quartz veins. (Tucker 21:374; 30:295; 31:369.)
390	Leiser Ray (California Comstock, Louisiana-California Co., Vanadium Gold Co.)	Mr. and Mrs. T.W. Craig, Goffs via Fenner	15,22	11N	18E	SB	Northeast of Goffs. Two parallel quartz veins in granite, 4 to 12 ft. wide, strike east, dip 45° N. Vanadium occurs as vanadinite and thin coatings of cuprodescloizite, a copper-lead-zinc vanadate, along seams in the quartz. Lead, gold and silver also present. Developed by 925-ft. vertical shaft with levels at 212,250,300 ft. and 6 others at 100-ft. intervals; over 6000 ft. lateral workings. Another shaft 130 ft. deep located 187 ft. south. Despite several attempts, no successful recovery of vanadium minerals. Last effort by California Comstock Gold Mines, Ltd., 1936-37. Idle. (Boalich 18:13,27; Cloudman 19:849, 850-852; Eric 48:310; Newman 23:310-311; Tucker 21:374; 30:296; 31:369; 40:70.)
	Lombard and Main (California Vanadium Co.)						See also under tungsten. Vanadinite and cuprodescloizite associated with gold and lead minerals in quartz veins cutting granite (Cloudman 19:845,849-850; Tucker 21:374.)
	Louisiana-California Company						See Leiser Ray. (Boalich 18:13; Cloudman 19:849,850-852; Eric 48:310; Tucker 21:374; 30:296; 31:369.)
	Vanadium Gold Company						See Leiser Ray. (Newman 23:310-311.)
	Vanadium King	A.L. Moorhead and W.F. Chausse, Goffs					"4 miles northeast of Klinefelter". Ore carries vanadinite and reported to assay 3% V_2O_5. (Tucker 21:374; 30:296; 31:369.)

VANADIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	War Eagle						See under lead-silver-zinc. In early 1930's milling operations on dump material produced concentrates which assayed 4 to 6% V_2O_5. (Tucker 34:325.)

ASBESTOS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
391	Cronese	A.B. McAntire, Los Angeles and Elmo Proctor, Yermo	14,15	12N	9E	SB	Southeast of Soda Lake, south of Baker. Chrysotile and amphibole asbestos reported occurring in dolomitic limestone along a belt of serpentine. Undeveloped deposits. (Tucker 30:296; 31:370; 43:508, pl.7.)
	Fire-Proof (Scorpion)	J.B. Friend, Victorville (1906)		9N	4W	SB	West of Cottonwood. Undeveloped deposit; "asbestos" of undetermined quality is reported to occur in a seam in shale. (Aubury 06:263; Cloudman 19:852; Crossman 90:236; Tucker 21:334.)
392	Golconda (Hicks)	W.E. Leahy, 4238 Edgehill Dr., Los Angeles. Leased to Pacific Petro-Chemical Corp., 20700 So. Figueroa St., Torrance	36	9N	4W	SB	West of Hodge, Barstow area. Possibly same as Fire-Proof and Scorpion. (Aubury 06:263; Cloudman 19:852; Crossman 90:236; Tucker 30:297; 30:271; 43:508; pl.7; herein.)
	Hicks						See Golconda. "Amphibole asbestos in belt of serpentine, not of sufficient extent to be of economic importance. Undeveloped". (Aubury 06:263; Cloudman 19:852; Crossman 90:236; Tucker 30:297; 30:370-371; 43:508.)
	Scorpion	Undetermined					See Fire-Proof, Golconda. (Aubury 06:263; Cloudman 19:852; Crossman 90:236.)

BARITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Ball	Red Seal Chemical Co., O.H. Ball, pres., Los Angeles	20?	12N	2E	SB	North of Barstow near Camp Erwin road. White barite; vein, 4 to 6 ft. wide, dips 80°; in andesite. Sp. gr. reported 4.22 to 4.33. Developed by open cuts and shallow shafts. (Tucker 43:508, pl.7.)
393	Barium Queen	Ellis Mallery and assoc., 214 H.W. Hellman Bldg., Los Angeles (1930)	22,27	10N	1W	SB	West of Calico district. Series of parallel barite-bearing veins dip 70° in quartzite and schist. Main vein exposed for 4500 ft. on surface, 4 to 5 ft. wide; reported grade 85 to 96 percent barite. Opened about 1915-16. Explored by 250-ft. drift, and 6 shafts 25 to 60 ft. deep. Twenty carloads of material shipped by 1930 for oil-well drilling mud. (Bradley 30:54; Cloudman 19:853; Tucker 21:334; 30:297; 31:371; 40:249; 43:509, pl. 7.)
	Big Medicine	George Parks and W.E. (Doc) Smith, Barstow. Leased to J.B. Walker, Barstow. (1930)	3	10N	1W	SB	South of Lead Mountain, west of Calico district. Gently east-dipping, coarse to fine-crystalline barite-bearing veins 4 to 8 ft. wide, in weathered schistose and dolomitic rocks. Exposed by open cut 15 ft. deep, 20 ft. wide and 50 ft. long. (Tucker 30:297; 371; 40:249; 43:509, pl 7.)
	Foshay Pass	Thomas Gannon and A.A. Irish, Fenner (1921)		10N or 10N	13E or 14E	SB	Providence Mts. about 10 miles southeast of Kelso. Series of parallel barite-bearing veins, up to 1 ft. wide, dip vertically in granite. Assay reported 85% $BaSO_4$. Long idle. (Tucker 21:334; 30:297; 31:371.)
394	Hansen	H.B. Hansen, Los Angeles. Leased to H.A. Hukill, Ludlow (1930)	30	8N	8E	SB	Lavic district, three miles north of Ludlow. Several parallel barite-hematite-bearing veins, 4 to 14 ft. wide, dip 45° in basalt. Developed by 250 ft. adit 60 ft. below outcrop. Ore shoot 150 ft. long on vein averaging 6 ft. wide stoped from 50 ft. level to surface. Sixty carloads of crude barite, average sp.gr. of 4.25, shipped prior to 1930 for oil well drilling mud. (Bradley 30:54-55; Hewett 36:150; Tucker 30:298; 31:371-372; 40:249; 43:509, pl.7.)

BARITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
395	Lead Mountain	Pacific Base Metals Co., A. Arthur Cohen, pres., 727 Subway Terminal Bldg., Los Angeles (1943)	36	10N	1W	SB	Grapevine district, 6 miles north of Barstow. See also under lead-silver-zinc. Barite-rich gangue of lead-silver vein concentrated for barite content during 1931-1933. Several thousand tons of material concentrated to a sp. gr. of 4.2. In 1937 a number of cars of ore was mined from surface cuts. (Tucker 30:298; 31:351,372; 40:249-250; 43:484,509.)
	Massen	J.H. Massen	20?	11N	6E	SB	Southeast of Afton. Small stringers of "good quality" barite, 2 to 6 inches wide, occur on limestone-schist contact. (Tucker 21:334; 30:298; 372.)
	Mansfield	O.D. Mansfield, Barstow (1919)		10N	1E	SB	Undeveloped deposit 6 miles north of Barstow. Vein of slightly iron-stained white barite in limestone; 3 ft. wide and reported traceable for 2000 ft. Long idle. (Cloudman 19:853; Tucker 21:334; 30:298; 31:372; 40:250.)
	Mountain Pass						Mountain Pass area. See under rare-earth elements. Barite concentrate produced from gangue of rare-earth deposit.
	Run-over						See Waterman. Also under silver. (Bradley 30:55.)
	Silver Spar	Undetermined	5	10N	1E	SB	Calico district. Vein 3 ft. wide, of massive, bladed barite; dip 70°; in andesite; exposed for over 500 ft. on surface and to depth of 135 ft. by a shaft. Long idle. (Hewett 36:149-150.)
	Waterloo						See Waterman. Also under silver. (Bradley 30:55.)
	Waterman	Cooper Shapley (lessee) Bishop (1930)					West Calico district. See under silver. Barite for oil well drilling mud recovered from mill tailings dumps of Waterman, Run-over, and Waterloo mines, averaging 23% barite. Concentrate, having sp. gr. of 4.3 produced in flotation plant in 1930. Long idle. (Bradley 30:55; Tucker

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Waterman (continued)						30:299; 31:373; 40:250.)

CLAY

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Balch Bentonite	Edward Sexton, Los Angeles (1930)	10	12N	11E	SB	In Old Dad Mts. Bentonite clay beds 10 ft. thick. Prospected by several open cuts. (Tucker 30:305; 31:379; 43:509, pl.7.)
	Barber Bentonite	A.M. Barber, Los Angeles	6	13N	4E	SB	South of Tiefort Mt. White bentonite reported to have surface exposure 300 ft. wide, 3000 ft. long. Prospected by 2 open cuts. (Tucker 30:305-306; 31:380; 43:509, pl. 7.)
	Bomber Moon	A.H. Bornfell, 2121 N. Windsor Ave., Altadena (1947)	17	10N	2E	SB	East Calico district, north of Yermo. Bed of bentonite 1 to 5 ft. thick, 4000 to 5000 ft. in exposed length; along folds in Miocene lake sediments. Explored by 39-ft. shaft and 15-ft. open cut. Production undetermined. Idle.
	Brown	Brown Mineral Co., Fred Brown, 4553 Kassebaum Ave., El Monte	13	1S	23E	SB	South of Vidal. Bentonitic clay used for trace mineral carrier in stock feed. Pulverizing plant at Vidal. Worked intermittently.
396	C. and M.	W.W. Hartman, 1230 E. 109th St., Los Angeles. Leased to S.E. Chiapella, 1625 No. Las Palmas Ave., Los Angeles and L.M. Moon, 4367 Sepulveda Blvd., Sherman Oaks	19	14N	18E	SB	Southwest part of Castle Mts. (Herein.)
397	C-1 Hart (Coors)	Southern California Minerals Co., 320 So. Mission Rd., Los Angeles	18,19	14N	18E	SB	Southwest part of Castle Mts. Kaolin. (Dietrich 28:194-195, 264-265; Hewett 36:173-174; Tucker 30:299; 31:373; 43:511, pl.7; Turner 50:145; herein.)
	California Talc Company						See Hector bentonite deposit. (Hewett 36:174; Tucker 30:

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	California Talc Company Bentonite (continued)						306; 31:380; 40:81-82; 40:250-253; 43:509-510, pl.7.)
	Carewe - Morton						Carewe - Morton Enterprise Co. operated part of Horner Bentonite deposits during early 1930's. See Hector Bentonite. (Tucker 31:380.)
	Coors						See C-1 Hart. (Dietrich 28:194-195,264-265; Hewett 36:173-174; Tucker 30:299; 31:373; 43:511, pl.7.)
398	Cronese Mud	T. and T. Oil Co., Santa Fe Springs. Leased to Macco Corp., 14409 S. Paramount Blvd Paramount	18,19 13,24	12N 12N	7E 6E	SB SB	Cronese Lake. Operated in recent years to supply impermeable material for canal and reservoir linings.
	Ewrite (Eyrite, Horner)	Oscar Hoerner and Assoc., Newberry. Leased to National Lead Co., Baroid Sales Div., 830 Ducommon St., Los Angeles					See Hector Bentonite. (Tucker 40:253; 43:510, pl.7.)
	Eyrite						Same as Ewrite. See Hector bentonite.
	Gladding McBean	Gladding McBean, and Co., 2901 Los Feliz Blvd., Los Angeles	15	7N	4W	SB	North of Oro Grande. Buff-burning clay. Has been mined intermittently in small quantities for manufacture of face brick. (Dietrich 28:195,314; Tucker 30:299-300; 31:373-374.)
399	Golconda	W.E. Leahy, 4238 Edgehill Dr., Los Angeles (1943)	36	9N	4W	SB	West of Hodge. Incompletely-altered, layered tuff, white to gray in color; prospected by open pit 50 ft. long, 25 ft. wide, 10 ft. deep. Small amount removed for tests. (Tucker 43:511, pl.7.)

CLAY (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
400	Hector Bentonite (California Talc Company Bentonite, Ewrite, Horner Bentonite)	National Lead Co., Baroid Sales Div., 830 Ducommon St., Los Angeles	6,22-27 incl., 35	8N	5E	SB	West of Mt. Pisgah. (Foshag 36:238-244; Hewett 36:174; Ross 45:27,32,35; Tucker 30:306; 31:380-381; 40:81-82; 40:250-253; 43:509-510; pl.7. herein.)
			31	9N	5E	SB	
	Henz Bentonite	Harry F. Heather, 236 So. Oak Knoll Ave., Pasadena		9N	4E	SB	Northwest of Hector. Bentonitic clay in lake beds.
	Holliman and Murphy	R.H. Holliman and D. Murphy, Cima	14	12N	14E	SB	South of Cima on west slope Mud Hills. Three beds of white, semi-plastic clay 6 to 15 ft. thick and intermittently exposed for 2000 ft. along strike. Tested by shallow pits. (Dietrich 28:195; Tucker 30:300; 31:374; 43:511, pl.7.)
	Horner Bentonite						Same as Ewrite. See Hector Bentonite. (Tucker 30:306; 31:380-381.)
	Hunger and McPhillips Bentonite (Smith Bentonite)	Wm. E. and Mary E. Hunger, and R.J. McPhillips, 9821 Burgen Ave., Los Angeles	26 ?	6N	14E	SB	North of Cadiz. Bentonitic clay 5 to 10 ft. thick. About 5 tons per year mined from shallow cuts and one 70-ft. adit. Clay ground and sold for veterinary poultice packs. (Tucker 43:511, pl.7.)
401	Inerto Bentonite	Inerto Company, 1489 Folsom St., San Francisco	27,28 34,35	8N	5E	SB	Herein.
	Le Feure Clay	C.B. Le Feure, Los Angeles (1930)	26 (?)	6N	14E	SB	North of Cadiz. Clay beds 14 ft. thick. (Tucker 30:300; 31:374; 43:511, pl.7.)
402	Millet	Kennedy Minerals Co., 2550 E. Olympic Blvd., Los Angeles	31	9N	3W	SB	West of Hodge. White to buff, buff-burning, plastic clay in 10 to 20 ft. bed, exposed discontinuously for ½ mile. Prospected by open cuts. (Dietrich 28:195-196; 288; Tucker 30:300; 31:374; 43:512, pl.7.)

CLAY (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
403	P.S. Hart, (Pacific Kaolin, Standard Sanitary)	Gladding McBean and Co., 2901 Los Feliz Ave., Los Angeles	19	14N	18E	SB	Southwest part Castle Mts. (Dietrich 28:196-198; Hewett 36:173-174; Tucker 30:300; 31:374-375; 43:513, pl. 7; herein.)
404	Pacific Bentonite	Luis Martinez, Red Mountain	29	28S	41E	MD	North of Randsburg. (Tucker 43:510, pl.7; herein.)
	Pacific Kaolin						See Standard Sanitary and P.S. Hart. (Dietrich 28:196, 197.)
	Siberia	George Benjamin and Wm. Melrose, Amboy (1943)	4	6N	9E	SB	West of Siberia. Altered volcanic material, capped by basalt. (Tucker 43:512, pl. 7.)
	Smith Bentonite						See Hunger and McPhillips Bentonite. (Tucker 43:511, pl. 7.)
	Standard Sanitary						See P.S. Hart. (Dietrich 28:196-198,264-265; Hewett 36:173-174; Tucker 30:300; 31:374-375; 43:513, pl.7.)
405	U.S. Bentonite	Undetermined	32	28S	41E	MD	North of Randsburg. Bentonite deposits similar to the nearby Pacific deposits. Worked mainly by open cuts.
406	Undetermined	Undetermined	13	10N	2E	SB	East of Calico district. northeast of Yermo. Bentonite layer 4 ft. thick in near-horizontal tuffaceous lake sediments under alluvial boulder wash. Exposed in area 200 ft. square in gully by bulldozer cuts, 20-ft. shaft and 30-ft. adit, partly caved. Production undetermined. Idle.

DIMENSION STONE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Brannigan						In Old Dad Mt., east of Baker. Small sandstone quarries on claims of Brannigan gold mine. See Brannigan under gold.
407	Brownstone granite	J.W. Auchinachi, Victorville (1906)	34	6N	4W	SB	North of Victorville. Granite quarry opened prior to 1906. Used for building and monument stone. (Aubury 06:50-51.)
	Cadiz marble						See Vaughan marble. (Aubury 06:102.)
	Clemens granite	Undetermined		6N	4W	SB	Three and a half miles north of Victorville. A granite quarry active in early 1890's. (Crawford 94:386.)
	Colton marble	California Portland Cement Co., 601 W. 5th St., Los Angeles	19	1S	4W	SB	Property on south side of Slover Mt. Formerly leased to Colton Marble Company which began operation prior to 1900. Marble used in numerous buildings in San Francisco and Los Angeles. (Aubury 06:103-104; Goodyear 88:504.)
408	Corona granite	Fairchild-Gilmore-Wilton Co., Pacific Electric Bldg., Los Angeles (1906)	3	5N	4W	SB	Northeast of Victorville. Paving blocks made from granite boulders. Opened prior to 1906. (Aubury 06:51.)
409	Delfante sandstone	Frank Rathbun, Wheaton Springs, and Jack Delfante, Las Vegas, Nevada	25(?)	16N	13E	SB proj.	(Herein.)
	Gem						See Verde Antique marble.
410	Gold Mountain ornamental stone	Alford Coleman, 661 W. 27th St., San Pedro	6,7 1,12	2N 2N	2E 1E	SB SB	San Bernardino Mts., Baldwin Lake area. (Herein.)
	Kimball						See Verde Antique marble.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
411	Leahy and Turner granite (Turner and Leahy)	P.H. Leahy and J.C. Turner, Victorville (1906)	28	6N	4W	SB	Southwest slope of Silver Mt., north of Victorville. Granite quarry opened in late 1800's. Building stone used in Ferry Bldg., San Francisco. (Aubury 06:51; Crawford 94:380.)
412	Mentone sandstone	Mentone Sandstone Co. (1906)	7	1S	1W	SB	Mill Creek in San Bernardino Mts. Sandstone quarry; operated prior to 1903. A tawny, medium-grained rock, interbedded with shale. Used in Hall of Records, San Bernardino. (Aubury 06:132; Cloudman 19:896.)
	Morongo onyx	Undetermined		1N	3E	SB	East slope San Bernardino Mts. (Tucker 43:pl.7.)
413	Oro Grande granite	Undetermined	28,29	6N	4W	SB	Southeast of Oro Grande. Granite paving blocks, building stone and monument stone obtained from boulders and small quarries. Opened in late 1800's; inactive by 1904. (Aubury 06:48-50; Cloudman 19:897.)
	Ribbon Rock	Ralph W. Ross, 710½ Park Ave., South Pasadena	8	8N	10E	SB	In northern Bristol Mts. Red and brown, banded marble onyx. Largely undeveloped. Small amounts removed for test purposes. Idle.
414	St. John granite	Hesperia Land and Water Co. (1906)	10	5N	4W	SB	Upper narrows of Mojave River, southeast of Victorville. Granite quarry opened prior to 1890, idle by 1894. Yielded building stone, curbing and paving blocks. Marketed as far as San Francisco. (Aubury 06:51; Crawford 94:386; Crossman 90:225.)
415	Searchlight	W.J. Collier, Searchlight, Nevada	29	15N	18E	SB proj.	North end of Castle Mts. Pale-gray, evenly bedded tuffaceous sandstone being developed as possible source of building stone in 1952. A medium-grained, moderately soft rock; part of Tertiary volcanic series. Large, easily recoverable reserves. Was idle in May 1952.
	Sheerer granite (Sherer)						See in section on sand and gravel, crushed rock and riprap.

DIMENSION STONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Sherer						Sheerer.
416	Southern California sandstone	Southern California Sandstone Co. (1906)	7	1S	1W	SB	Mill Creek, San Bernardino Mts. Sandstone quarry commenced operating in 1890, inactive by 1904. (Aubury 06:132; Crossman 90:225.)
	Stockholm granite						See Victor granite.
417	Swanson granite	Clara Swanson, Victorville	30,31 36	5N 5N	2E 1E	SB SB	Northeast of Lucerne Valley. (Herein.)
418	Texas granite	W.H. Johnson, Victorville	29	5N	2E	SB	Northeast of Lucerne Valley. (Tucker 40:82; 43:515, pl. 7; herein.)
419	Three Colored marble	E.T. Hillis, Barstow (1919)	11	6N	2W	SB	Northeast slope Sidewinder Mts. Brecciated marble, mottled in green, black, and white. As much as 200 ft. thick Worked only on small scale. (Cloudman 19:881-883; Pack 14: 365-367; Tucker 43:528, pl.7.)
	Turner and Leahy granite						See Leahy and Turner granite. (Crawford 94:386.)
420	Vaughan marble (Cadiz)	Vaughan Marble Co., 437 S. Hill St., Los Angeles (1943)	2,11 22,26, 27,28	5N 6N	14E 14E	SB SB	Southwest slope of Marble Mts. Quarries along 2-mile belt of Cambrian marble. Rock ranges from highly colored and varigated to black and gray. Operated 1937-1939; marble polished in Los Angeles and used in buildings in Los Angeles and San Francisco. Large reserves. Idle. (Aubury 06:102; Tucker 43:529, pl.7.)
421	Verde Antique Marble (Gem, Kimball)	Mojave Consolidated Development Co., 175 Crocker Bldg., San Francisco (1906)	28	7N	2W	SB	Northeast of Victorville. Verde antique quarry opened in late 1800's and operated intermittently. Product was sawed, polished and sold as interior ornamental stone. (Aubury 06:147-148; Cloudman 19:882; Pack 14:367-368; Tucker 43:531, pl.7.)

DIMENSION STONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Victor granite (Stockholm)	James Hargraves, Victorville (1915)	3	5N	4W	SB	Northeast of Victorville. Paving blocks and curbstones quarried from boulders. Opened prior to 1906. (Aubury 06:51; Cloudman 19:898.)

FELDSPAR

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Clement and Blackburn	Ada Clement, Pleasanton (1931)					One and a half miles south of Oro Grande. Orthoclase-bearing pegmatite dikes, 3 to 10 ft. wide in granite. (Sampson 31:426; Tucker 20:342.)
	Ivanpah						See under silica.
	Keystone and Lucky Jim	C.E. Lillibridge and E.R.E. Nonhoff, Corona (1931)	20, 29	2N	3W	SB	Arrowhead Lake area. Feldspar-quartz body in granite; max. width 20 ft. Small production of feldspar, quartz, and mica reported. (Sampson 31:426,427; Tucker 31:377.)
	Lucky Betty						See under silica.
422	McKnight Cornishstone	H.E. McKnight (deceased) Los Angeles (1943)	16	7N	2E	SB	East slope Ord Mts. at Willis Well. Small body of felsitic quartz-feldspar rock within aplitic granitic mass. Explored by single pit 5 by 10 by 4 ft. deep. Tested for ceramic use. No production. Long idle. (Gardner 40:pl. 2; Tucker 30:305; 31:379,445; 43:543, pl.7.)
	Sloan	J.H. Sloan, Barstow (1931)		10N	3W	SB	North of Hinkley. Several carloads shipped 1916. (Cloudman 19:862,863; Sampson 31:426; Tucker 20:342.)
423	White Butte	Gladding McBean and Co. 2901 Los Feliz Blvd., Los Angeles	18	31S	44E	MD	East of Fremont Peak. (Tucker 43:513, pl.7; Wright 50:160; herein.)
	White Rock	P. Gerber, 7364 Sunset Blvd., Los Angeles (1931)					Ten miles southeast of Goffs. Said to be feldspar-quartz body, 15 to 18 ft. wide; in granite. Twenty-five ft. adit. (Tucker 31:379.)

FLUORSPAR

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Afton						See Afton Canyon.
424	Afton Canyon deposits (Includes numerous fluorite occurrences referred to under the names Afton, Bighorn Number 9, Kings, and Massen.)	Undetermined	7	10N	6E	SB	Fluorspar, with quartz, calcite and siderite, occurs in veins in andesite and basalt. One zone, about one-eighth mile wide and one mile long contains abundant veins from one-half inch to 8 inches wide; most strike N. 70° E. and dip vertically. In area $1\frac{1}{2}$ miles west-southwest, small fluorite tonnage obtained from vertical vein, 4 ft. in maximum width, along a granite-andesite contact. Vein followed by 150-foot shaft. (Burchard 34:373, 374; Crosby 51:633-636; Hewett 36:171,172; Tucker 20:343; 30:301-302; 31:375,376; 43:513,514, pl.7.)
	Baxter	J. Garrity, Baxter (1930)					"South of Baxter" (Tucker 30:302; 31:376.)
	Big Horn Number 9						See Afton Canyon.
	Clark Mountain						See Juniper.
425	Douglass Number 1 (War Eagle)	G.W. Douglass, 8756 So. Grand Ave., Los Angeles		17N	13E	SB	Clark Mountain area. Fluorite- and sericite-bearing zone 200 ft. long and 10 ft. max. width. A replacement of Goodsprings dolomite along minor thrust fault. Fluorite content generally 50% to 60%. A prospect. (Crosby 51:630,631,634.)
426	Douglass Number 2	G.W. Douglass, 8756 So. Grand Avenue, Los Angeles		17N	13E	SB	Clark Mountain area. Fluorite-sericite alteration of Goodsprings dolomite along northwest-trending vertical fault. Bodies, generally 4 to 5 ft. wide, are discontinuously exposed for lateral distance of several hundred feet. Fluorite content as high as 50% or 60% but generally much lower. Explored by several cuts and 2 short southeast-trending adits. A prospect. (Crosby 51:629-631, 635.)

FLUORSPAR (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Freethinker						See Nipton
	French						See Ivanpah Mountains.
427	Green Hornet	Mrs. L.B. Garvell, 2580 Lincoln Blvd., San Bernardino	7, 8	6N	1E	SB	Sidewinder Mt. Irregular masses of fluorite occur in 5 parallel quartz veins which strike west, dip 80° S., and are mostly 4 to 6 ft. thick. The veins cut granitic rock. One vein is followed by 80-ft. shaft joined at the bottom by a 125-ft. easterly drift. From the drift a 40-ft. northerly cross-cut intersects another vein. Ten tons of sorted ore said to have averaged 85% CaF_2 and 12% SiO_2. (Crosby 51:634,636; Tucker 43:514, pl.7.)
	Ivanpah Mountains (French)	A.L. French	8 (?)	14N	14E	SB	South Ivanpah Mts. Quartz monzonite porphyry contains irregular, partly sericitized zone 75 ft. in max. dimension. Fluorite along shears within zone. A prospect. (Crosby 51:636)
428	Juniper (Clark Mountain, Korfist, Korfist Number 1)	Jerry Korfist, Baker		17N	13E	SB	Clark Mountain area. Bodies containing sericite and 40% to 60% fluorite are about 40 ft. in max. width, strike NW and dip 50° to 70° SW. Principal bodies confined to felt about 200 ft. long in Goodsprings dolomite. Explored by 85-ft. shaft, inclined southward at 60°, appended at 50-ft. level to 40-ft. west-trending and 30 ft. south-trending tunnel; also by several shallow pits. Numerous similar deposits but with smaller proportions of fluorite, exist in wider area. No fluorite shipped. (Crosby 51:625-631,634.)
	Kings						See Afton Canyon.
	Korfist						See Juniper.
	Korfist Number 1						See Juniper.

FLUORSPAR (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Live Oak						See Live Oak in tungsten section.
	Magna Number 1						See Nipton.
	Massen						See Afton Canyon.
	McDermott	Mrs. R.H. McDermott, Los Angeles (1930)					Nine miles east of Nipton. Fluorite vein 12 in. to 3 ft. wide. One 50-ft. shaft, one 60-ft. shaft and one adit 20 ft. long. (Tucker 30:302; 31:376.)
	McKinney	C.J. McKinney, F.C. Snyder, and D.R. Brown Victorville (1944)	1	6N	1W	SB	In Stoddard Range. Two fluorite-bearing quartz veins in granite. Larger vein, 10 ft. max. width, 600 ft. exposed length; strikes west, dips vertically. Three shafts; deepest 50 ft., with 110 ft. of drifts. Fluorite appears subcommercial. (Crosby 51:634,637; Tucker 43:514, pl.7.)
429	Nipton (Freethinker, Magna Number 1)	H.C. Moore, 1958½ Rodney Dr., Los Angeles. Leased to Fred A. Lawrence, 146 Hill Avenue Pasadena		15½N	17E	SB	East of Nipton. Several fluorite veins in Archean gneiss and quartzite. Largest is 18 in. wide and 40 ft. in exposed length. Various attitudes. Several cuts and short adits. A prospect. (Crosby 51:634,637.)
	Philadelphia						See Providence Mountain.
	Primer						See Primmer.
430	Primmer (Primer)	G.B. Primmer, 1470 Scott Ave., Los Angeles (1947)	26	7N	6W	SB	In Shadow Mts. Small discontinuous fluorite-calcite bodies in limestone; several inches to 4 ft. wide. Workings consist of a 15-ft. shaft, an open cut and 2 trenches. A prospect. (Crosby 51:635,637; Tucker 43:514, pl.7.)
	Providence Mountain (Philadelphia)	O.L. Hoerner, Newberry		9N	13E	SB proj.	Fluorite vein in granitic rock. Vein 6 ft. width, 50 ft. exposed length. Fluorite good quality; impurities minor. (Crosby 51:635, 637-638; Tucker 20:343; 30:302; 31:376.)

FLUORSPAR (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	War Eagle						See Douglass Number 1.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
431	Blue Quartz No. 1	Dr. R.H. Chapin, Box 756, Barstow. Leased to John A. Bowlton.	19	14N	1E	SB	Goldstone district. (Murdoch 48:306.)
432	East Camp	J.B. Wood (1905)	32,33, 4	16N 15N	11E 11E	SB SB	Turquoise deposits northwest of Yucca Grove. Turquoise veinlets, smears and dissemination zones in granitic rock associated with alunite and quartz. Widespread and numerous pits, cuts, and adits. Worked in period 1898-1903 by Toltec Gem Mining Co. (Cloudman 19:864-868; Heizer 44:335-336; Kunz 05:107-110, 152-153; Sperisen 38:71-73; Wright 50:167.)
433	Himalaya	Lippman Tannenbaum, New York (1905)	36 31	16N 16N	9E 10E	SB SB	Turquoise deposits northeast of Silver Lake. Similar to East Camp deposits worked by Himalaya Mining Co. in period 1897-1903. (Cloudman 19:864-868; Heizer 44:335-336; Kunz 05:107-110,153; Sperisen 38:71-73; Tucker 43:pl. 7; 73; Wright 50:167.)
434	Middle Camp (Stone Hammer)	J.B. Wood (1905)	32,33	16N	10E	SB	Turquoise deposits northeast of Silver Lake. Similar to East Camp deposits. Worked by Toltec Gem Mining Co. in period 1898-1903. (Cloudman 19:864-868; Kunz 05:107-110, 152-153; Heizer 44:335-336; Sperisen 38:71-73; Wright 50:167.)
	Myrick	F.M. Myrick (1919)		Approx. 18N	 1E	SB	East of Owl Hole Spring. Myrickite, a cinnabar-bearing chalcedony, first described from this location. (Cloudman 19:863; Sterrett 13:650; Tucker 30:map; 31:map.)
	Stone Hammer						See Middle Camp.
	Toltec						See West Camp.
435	West Camp (Toltec)	J.B. Wood (1905)	36 31	16N 16N	9E 10E	SB SB	Turquoise deposits northeast of Silver Lake. Similar to East Camp deposits. Worked by Toltec Gem Mining Co. in

GEMSTONES (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
435	West Camp (Toltec)(continued)						1898-1903. Most extensive workings in block 200 ft. by 100 ft. by 100 ft. deep. Thoroughly mined by adits, shafts winzes and stopes. (Cloudman 19:864-868; Heizer 44:335-336; Kunz 05:107-110,152-153; Sperisen 38:71-73; Tucker 43, pl.7; Wright 50:167.)

GRAPHITE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
436	Big Bear	Undetermined	28, 29, 32, 33	2N	2E	SB	San Bernardino Mts. south of Baldwin Lake. Graphitic schist extensively prospected. (Tucker 43:pl.7; herein.)
	Eva Canyon	Undetermined	14?	1N	8W	SB	South San Gabriel Mts., in Evey Canyon. Highly graphitic material; widths as great as 5 ft.; in decomposed, sheared crystalline schists associated with granite pegmatite. Graphite is crystalline, but very fine-grained and mixed with silicates, making economic extraction doubtful. Long idle. (Tucker 21:351.)
	Van Slyke	W.E. Van Slyke, 716 Fifth St., San Bernardino		Approx. 1N	1E	SB	San Bernardino Mts. near head of Santa Ana River, 15 miles from East Highlands. Reported soft, amorphous graphite, 50% pure. Long idle. (Aubury 06:280; Cloudman 19:868; Tucker 21:351.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
437	Adelanto	Southwestern Portland Cement Company, Victorville	2	6N	6W	SB	Six miles northwest of Adelanto. Extensive exposures of high-calcium limestone. Part of Oro Grande series. Undeveloped. (Logan 47:280; Tucker 43:516, pl.7.)
438	Arlington and Black Hawk (Black Hawk Mountains)	James Hay estate, Los Angeles	5,8,9, 16,17	3N	2E	SB proj.	Furnace limestone extensively exposed on claims of Santa Fe (Arlington and Black Hawk) gold mine, which see. Limestone undeveloped. (Aubury 06:102; Logan 47:280; Tucker 30:308; 31:382-383; 43:516, pl.7; Woodford 28:268-271.)
439	Baker	J.W. Neblett, Riverside (1947)	36	14N	8E	SB	One mile west of Baker. Hill underlain by Pennsylvanian crystalline limestone; massive, blue-gray. Undeveloped. (Logan 47:281; Tucker 31:383; 43:516, pl.7.)
	Baxter and Ballardie						See Cave Canyon.
440	Big Pine (Little Johnnie)	Big Pine Mining Corporation (1930)	6	3N	7W	SB	Northeastern San Gabriel Mts. Mostly in L.A. County. Undeveloped deposits of limestone. (Logan 47:281; Tucker 30:308; 31:383.)
	Cadiz marble						See Vaughan marble under dimension stone.
441	Cajon	Mrs. Lorin Foreman, Los Angeles (1947)	10	3N	7W	SB	In Lone Pine Canyon, west of Cajon Station. Limestone lenses in gneiss and schist. Quarries active in mid-1920's. Lime kiln operated briefly. (Logan 47:281-282; Tucker 31:383; 43:517, pl.7.)
442	California Dolomite Company	Nicholas Baxter and Norris Williams, Adelanto. Leased to California Dolomite Company, Inc., 10019 E. Park, Bellflower	32	8N	6W	SB	Herein.

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
443	California Portland Cement Company (Colton, Slover Mountain)	California Portland Cement Company, 612 S. Flower St., Los Angeles	19,30	1S	4W	SB	West of Colton. (Aubury 06:77, 102-104,,183-184; Cloudman 19:857-858,876,880,898; Crawford 94:380; 96:612,630; Logan 47:282; Tucker 21:335,336; 30:309; 31:384; 43:517, pl. 7; herein.)
444	Cave Canyon (Baxter and Ballardie, Evening Star, White Marble)	California Portland Cement Co., 612 So. Flower St., Los Angeles	11,12	11N	6E	SB	South of Cave Mt. (Cloudman 19:872-876; Logan 47:281; Tucker 30:308; 31:383; 43:516; pl. 7, herein.)
	Chalmers	A.F. Becker, 4278 Beverly Blvd., Los Angeles (1943)	29	6N	13E	SB	Southeast end of Bristol Mts. Extensive deposits of dolomite. Undeveloped. (Logan 47:282; Tucker 30:309; 31:384; 43:517-518, pl.7.)
445	Chubbuck (Chubbuck Lime Company, White Mountain Lime Company)	Reconstruction Finance Corp. Being purchased by White Mountain Lime Co., Harms Brothers, 5261 Stockton Blvd., Sacramento	10,11, 15,16, 21,22	3N	16E	SB	North end of Iron Mts. (Logan 47:283-284; Tucker 43:518-521, pl. 7, herein.)
	Chubbuck Lime Company						See Chubbuck.
	Chubbuck Limestone and Dolomite						See Chubbuck Reserve. May also refer to Chubbuck, which see.
446	Chubbuck Reserve (Chubbuck Limestone and Dolomite)	Reconstruction Finance Corp. Being purchased (1951) by White Mountain Lime Co., Harms Brothers, 5261 Stockton Blvd., Sacramento	17,20 21	6N	14E	SB	Southwest slope of Marble Mts. (Logan 47:283,284-287; Tucker 43:518, pl. 7, herein.)
447	Cima	James Vernon, Arlington R.F. Slaughter, River-	12,13, 24	15N	13E	SB	North of Cima. Large, undeveloped limestone deposit. (Logan 47:287; Tucker 30:309; 31:384; 43:521-522, pl. 7.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
447	Cima (continued)	side	7	15N	14E	SB	
	Colton						See California Portland Cement Co.
448	Cushenbury Canyon (Dunton)	Mineral Materials Co., 1145 Westminister Ave., Alhambra	10-16 incl.	3N	1E	SB	(Logan 47:288; herein.)
449	Devil's Canyon	San Bernardino Limestone Co., 1709 W. 8th St., Los Angeles (1947)	5	1N	4W	SB	Southwestern slope of San Bernardino Mts. Wide belt of white, crystalline limestone. Quarried in early 1940's. Idle. (Logan 47:288; Tucker 43:521, pl.7.)
	Dunton						See Cushenbury Canyon.
	Eureka						(Logan 47:288.) See White Lime Rock Company.
	Evening Star						See Cave Canyon.
	Excelsior						See White Lime Rock Company.
	Gem Quarry						See Verde Antique under dimension stone.
	Golden State Portland Cement Company						See Riverside Portland Cement Co.
	Hesperia	S.D. Greenwood, Clinton Ray, and Claire Dunton, Glendale	27,28, 33	4N	3W	SB	Seven miles east of Hesperia. Extensive deposits of dolomite. Undeveloped. (Logan 47:288-289; Tucker 43:521,523, pl.7.)
450	Hinkley	A.R. Mills, 3859 Main St., Riverside	11,12	9N	4W	SB	Five miles southwest of Hinkley. (Logan 47:289; Tucker 30:310; 31:385; 43:523, pl.7; herein.)
451	Ivanpah (O'Connell)	J.J. O'Connell, 437 N. Oakhurst Dr., Beverly Hills, and S.E. Chiapella, 1625 N. Las Palmas Ave., Los Angeles	9	14N	16E	SB	West slope New York Mts. (Logan 47:293; Tucker 30:311; 31:386; 43:524, pl.7; herein.)

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Johnson	Edward Johnson, Baker					Five miles south of Balch. Dolomite deposits. Undeveloped. (Logan 47:290.)
	Kimble mine						See Verde Antique under dimension stone.
	Lamb Bros.						See Sheep Creek. (Logan 47:290-292.)
	Lawton	John P. Lawton, Sierra Madre (1931)	18 13	2N 2N	5W 6W	SB SB	North of Keenbrook. Undeveloped deposits of limestone and dolomite. (Logan 47:292; Tucker 30:310; 31:385.)
	Little Johnnie						See Big Pine.
	Lucky Strike	C. Lillibridge and E.R.E. Nonhoff, Corona (1931)		2N	4W	SB	Southwest San Bernardino Mts. On Lake Arrowhead Highway. Limestone body about 150 to 200 ft. thick and 1000 ft. long. Undeveloped. (Logan 47:292; Tucker 30:310,311; 31:385-386.)
	Magnesium Giant	A.J. Rygh, 1409 Calumet Ave., Los Angeles (1947)	33	16N	11E	SB	Near Halloran Springs. Dolomite deposit. Undeveloped. (Logan 47:292.)
	Marble Placer	Undetermined	13	11N	6E	SB	South of Cave Mt. Probably now part of Cave Canyon property noted above. (Logan 47:292.)
	Mayflower	G.A. Childers, 128 N. Flower St., Los Angeles (1947)					Eight miles north of Amboy. Limestone layer, 10 ft. thick. Undeveloped. (Logan 42:292.)
	Mayflower						See White Lime Rock Company.
	McAntire and Proctor	A.B. McAntire, 7721 S. Main St., Los Angeles and Elmo Proctor, Yermo (1943)					Ten miles south of Baker. Extensively exposed variegated marble. Undeveloped. (Logan 47:292; Tucker 30:311; 31:386; 43:524.)

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
452	Mill Creek Limestone Co.	Mill Creek Limestone Co., John D. Scouller, vice pres., 6009 Santa Monica Blve., Los Angeles	22, 15	1S	1E	SB	Southeastern San Bernardino Mts. Limestone body in granite; 60 to 70 ft. thick, half a mile or more long. Quarried in 1942-43. Idle. (Logan 47:292-293.)
453	Mojave	Mojave Marl Company, 374 Court St., San Bernardino (1931)	7,8	8N	4W	SB	Three miles north of Helendale. Marly limestone layers in Pleistocene lake beds. Quarried in 1930's for use as soil conditioner. (Logan 47:293; Tucker 30:311; 31:386.)
	Morongo Onyx						See under dimension stone.
	O'Connell						See Ivanpah. (Logan 47:293; Tucker 30:311; 31:386; 43:524, pl.7.)
	Parker	W. Floyd, 1320 Angeleno St., Los Angeles (1931)					Seven miles east of Barstow. Marl deposits; undeveloped. Logan 47:294; Tucker 30:311; 31:386.)
	Peterson	Carl Peterson, Lucerne Post Office (1947). Leased to Marter Mining Co., 530 W. 6th St., Los Angeles	12	5N	1W	SB	North of Lucerne. Limestone intruded by granite. Partly altered to tactite. High-calcium crystalline limestone quarried in mid-1940's. (Logan 47:294.)
454	Rattlesnake Gulch	W.H. and W.E. Schmidt, Box 611, Yucca Valley	27,28	2N	3E	SB	Southeast of Baldwin Lake. (Herein.)
	Ribbon Rock						See under dimension stone.
455	Richter	Marter Mining Co., R.M. Richter, pres., 530 W. 6th St., Los Angeles (1947)	15	6N	1W	SB	North Lucerne Valley. Magnesite-bearing dolomitic limestone exposed on low hill. Quarried briefly in 1940's. (Logan 47:294-295; Tucker 43:524, pl.7.)

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
456	Riverside Cement Company (Golden State Portland Cement Company)	Riverside Cement Co., 621 S. Hope St., Los Angeles	4, 9,16, 17,25 9	6N 6N	4W 6W	SB SB	Vicinity of Oro Grande. (Cloudman 19:858-859; Logan 47:295; Tucker 21:336; 30:312, 313-314; 31:385; 43:524-525, pl.7; herein.)
	Schiedel	John Schiedel, 639 St. Paul Ave., Los Angeles (1931)	5,11 14	12N 13N	14E 15E	SB SB	Northern Providence Mts. Crystalline limestone deposit. Undeveloped. (Tucker 30: 311; 31:386-387.)
457	Sheep Creek (Lamb Brothers)	Lamb Bros. Leased to L. H. Maddux, 14 Apple St. Wrightwood	1,3,4, 10,15, 22	3N	7W	SB	North of Wrightwood. (Logan 47:290-292; herein.)
	Silver Dome	Silver Dome Mining Co.	9	32S	42E	MD	Thirteen miles northeast of Kramer. Large deposit of high-calcium limestone. Undeveloped. (Logan 47:295; Tucker 30:312; 31:387-388; 43:525, pl.7.)
	Silver Lake	G.M. Shelley, 847 N. Orange Grove Ave., Los Angeles (1931)	18,19	15N	8E	SB	Three miles west of Silver Lake. Extensive deposit of high-calcium limestone. Undeveloped. (Logan 47:295; Tucker 31:388; 43:525, pl.7.)
	Slover Mountain						See California Portland Cement Company.
458	Snow White	Giant Ledge Lead & Copper Co., R.J. Ingalls, 927 Palm Dr., Colton	32	14N	16E	SB	Southern New York Mts. on property of Giant Ledge mine, which see under copper. Extensive exposures of Goodsprings dolomite. (Logan 47:296; Tucker 30:312; 31:388; 43:525.)
459	Snowcap	Paul Tobeler, 2466 E. 56th St., Los Angeles	30	6N	13E	SB	Southeast end Bristol Mts. Paleozoic limestone and dolomite. Limestone reported to be 98.6 percent $CaCO_3$. Limestone along a north-trending ridge, stripped of its thin overburden over area 150 ft. long, 50 to 100 ft. wide. Small bench has been cut. Owner reports few thousand tons have been produced for test purposes. (Logan 47:295-296; Tucker 30:312; 31:388; 43:525, pl.7.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
460	Southwestern Portland Cement Co.	Southwestern Portland Cement Co., 1034 Wilshire Blvd., Los Angeles	2,10, 11,14, 15,16	6N	4W	SB	Properties northwest, north and northeast of Victorville. (Cloudman 19:859-860; Logan 47:296; Tucker 21:337; 30:313 31:388-389; 43:525-528, pl.7; herein.)
			5,6,8	6N	2W	SB	
			2	6N	6W	SB	
	Sugar Loaf Mountain	Albert Rose, Big Bear Lake, (1947)	17	1N	2E	SB	South of Baldwin Lake. Dolomite deposit. Extensive but undeveloped. (Logan 47:296; Tucker 43:528, pl.7.)
	Three Colored Marble						See under dimension stone.
	Twin Buttes	Ira Judson Coe, address undetermined	9	5N	15E	SB	Northwest side Ship Mts. Large reserves of dolomite. (Logan 47:296.)
461	Van Dusen Canyon	J.R. Anderson and R.C. Huston, 1426 Guess St., Rosemead	3	2N	1E	SB	(Herein.)
	Vaughan						See under dimension stone. (Logan 47:297-298; Tucker 43:528-531, pl.7.)
	Verde Antique quarry (Gem Quarry, Kimble Mine)						See under dimension stone.
462	Victorville Limerock Company	Victorville Limerock Co., Victorville, Mr. Elmer A. Piercy, Gen. Mgr.	25,36	6N	4W	SB	Northeast of Victorville. (Logan 47:298; Tucker 30:345; 43:531; herein.)
463	White Lime Rock Company (Eureka, Excelsior, Mayflower)	Riverside Cement Co., 621 So. Hope St., Los Angeles. Leased to White Lime Rock Co., 5953 Crenshaw Blvd.,	25,26 35	6N	4W	SB	Northeast of Victorville. Opened early 1949. White limestone crushed for use as roofing granules.

LIMESTONE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
463	White Lime Rock Company (Eureka, Excelsior, May-flower) (continued)	Los Angeles					
	White Marble						See Cave Canyon.
	White Mountain Lime Company						See Chubbuck.
464	White Rock	Walter Jenkins, Joshua Tree	32	3N	2E	SB proj.	(Herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
465	Afton Canyon (Cliffside, Van Deventer)	C.B. Van Deventer, 663 2nd St., San Bernardino (1943)	21	11N	6E	SB	South side Mojave River in Afton Canyon east of Afton. Bedded, white to pink, fine-grained magnesite, 30 to 75 ft. thick, crops out for a horizontal distance of 400 to 500 ft. in steep canyon wall and parallel to overlying conglomerate and underlying conglomeratic siltstone and thin basalt flow. A few carloads of ore mined from short adits by Cliffside Magnesite Co. in 1917-1918. Carried by 1900-ft. aerial tram across river to railroad, and shipped to International Magnesite Co., Chula Vista. Reserve of 100,000 to 200,000 tons of ore above canyon floor with 30% MgO content but silica and lime content high. Idle. (Bradley 25:72-75; Hewett 36:117-118; Schlocker 42:6-7; Tucker 21:353-354; 30:314; 31:390; 43:532, pl.7; Vitaliano 50:365.)
466	Ball	O.H. Ball, 2024 West 62nd St., Los Angeles (1943)	3	6N	2W	SB	North slope Sidewinder Mt. (Tucker 43:532, pl.7; herein.)
	Ball						See Kramer Hills. (Tucker 43:67.)
467	Capitan	Oscar Hendrickson and associates, P.O. Box 57, Needles	29	8N	21E	SB	Southwest of Needles. White- to chocolate-colored, thinly laminated beds of magnesite in thin-bedded Tertiary dolomitic limestone. Magnesite of sedimentary origin. Strike of beds N. 20° W., dip 60°-70° NE. Explored by 2 shallow inclined shafts, one caved, and a large shallow open pit, the main part of which is 125 ft. long, 75 ft. wide. Smaller pit nearby. Explored 1943-44. Production undetermined. Idle. (Vitaliano 50:357-372.)
	Cima						See New Trail. (Hewett 36:118-119; Schlocker 42:13.)
	Cliffside						See Afton Canyon. (Bradley 25:72-75.)
468	Kramer Hills (Ball)	O.H. Ball, 2024 W.	3,4	9N	6W	SB	Southwest part of Kramer Hills. (Tucker 43:67; 43:532-533,

MAGNESITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
468	Kramer Hills (Ball) (continued)	62nd St., Los Angeles (1943)					pl.7., herein.)
	Marter						See Richter.
469	Needles (White Moon)	Bert E. Hubbard and Wm. M. White, 6263 Vesper St., Van Nuys (1943)	15,22	8N	21E	SB	Southwest of Needles. Thinly-bedded, fine-grained, white magnesite of high purity enclosed in Tertiary sediments, principally dolomite, tuff and shale. Outcrops confined to area 600 ft. wide, 2400 ft. long. Estimated max. depth 100 ft. Estimated reserve of 117,000 tons of ore having maximum of 10% CaO. Magnesite of sedimentary origin. Considerable exploration work in 1935 by Westvaco Chem. Corp. Food and Machinery Div. Leased in 1943 to J. Lex Brown, San Bernardino, who sub-leased to American Magnesite Co., I. Bromberg pres. One shipment made to plant at Chula Vista. Idle since. (Schlocker 42:9-10; Tucker 43:138; 43:534-535, pl.7; Vitaliano 50:357-372.)
470	New Trail (Cima)	New Trail Mining Co., Mrs. H.I. Kent, pres., La Calino Ranch, Riverside. Leased to W.H. Hile, 95 Monterey Rd., So. Pasadena	15,16, 21,22	15N	14E	SB	Ivanpah Mts. (Hewett 36:118-119; Schlocker 42:13; Tucker 30:314-315; 31:390; 43:533, pl.7; herein.)
	Quaker group	Geo. W. Elder, 799 Oak St., San Francisco (1925)					Providence Mts. 12 miles south of Cima. Magnesite along contact between limestone hanging wall and serpentine footwall. Shipped 200 tons prior to World War I. (Bradley 25:74,75; Hewett 36:119)
	Richter (Marter)	R.M. Richter, Marter Mining Co., 530 W. 6th St., Los Angeles	15	6N	1W	SB	North slope Sidewinder Mts. See also under limestone. Nearly oval hill of Paleozoic dolomite, 600 by 400 ft. at base and rising 50 to 75 ft. above detrital fan, highly fractured and fractures filled with white, high-quality

MAGNESITE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Richter (Marter) (continued)						magnesite. About 60 tons shipped from prospect holes. Idle. (Tucker 43:533-534, pl.7.)
	Van Deventer						See Afton Canyon.
	White Moon						See Needles. (Tucker 43:138; 43:534-535, pl.7.)

PERLITE, PUMICE, PUMICITE, & VOLCANIC CINDERS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
471	Castle Mountains perlite (includes Cedar Top, Cox, and More-Lite deposits)	Listed under Cedar Top, Cox, and More-Lite	29	15N	18E	SB	North end of Castle Mts. (Herein.)
	Cedar Top perlite	L.S. Whaley Lumber Co., 6544 Cherry Ave., Long Beach	29	15N	18E	SB	North end of Castle Mts. See Castle Mountains perlite.
	Cox perlite	Lewis Cox, 810½ Main St., Las Vegas, Nevada	29	15N	18E	SB	North end of Castle Mts. See Castle Mountains perlite.
472	Craik perlite	J.A. Craik, 380 N. Hill Ave., Pasadena		4N	21E	SB	East side of Turtle Mts. (Herein.)
473	Dish hill volcanic cinders	State of California. Leased to Velvatone Stucco Products Co., 2066 Hyde Park Blvd., Los Angeles	16	6N	10E	SB	At Trojan siding on Santa Fe railroad (Herein.)
474	Glassy Rock perlite	G.W. Rust, et al., Box 718, Kentfield	32	8N	10E	SB	Southwest part of Bristol Mts. (Herein.)
475	Harper perlite	H.F. Heather, 2365 Oak Knoll Ave., Pasadena	22	8N	13E	SB	Northeast of Amboy. (Herein.)
476	Hicks perlite	J.E. Hicks, 5944 Middleton St., Huntington Park	35,36	31S	44E	MD	Northwest of Barstow. (Herein.)
	More-Lite perlite	More-Lite Minerals Corp., Riverside	29	15N	18E	SB	North end of Castle Mts. See Castle Mountains perlite.
477	Mt. Pisgah volcanic cin-	H.F. Heather, 2365 Oak	32	8N	6E	SB	West of Ludlow (Herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
477	Mt. Pisgah volcanic cinders (continued)	Knoll Ave., Pasadena, Oscar Hoerner, 5211 Delaware Ave., Los Angeles, and F.A. Wilson, 3373 D Street, San Bernardino	32	8N	6E	SB	West of Ludlow (Herein.)
478	Pilot Knob perlite	Joe Foisie and Chet Williams, Johannesburg	3	29S	44E	MD	Northeast of Randsburg. (Herein.)
479	Santa Fe Railway pumicite	Santa Fe Railway, Los Angeles office at 121 E. 6th St.	13	5N	15E	SB	Southeast of Siam. (Herein.)
	Santischi perlite	Fred Santschi, Bagdad	8,9, 10	7N	11E	SB	Northwest part of Bristol Mts. Lenses of perlite within rhyolite or at contact of rhyolite and tuff or tuff breccia; lenses as much as 30 ft. thick and several 100 ft. in exposed length. No production.
	Tomiyasu perlite	More-Lite Minerals Corp., Riverside	29	15N	18E	SB	Northern part of Castle Mts. Quarry formerly worked by N. Tomiyasu.
480	Williams Brothers pumice	F.M. Williams, Star Route, Barstow	7,8, 17,18	32S	46E	MD	Northeast of Harper Dry Lake. (Herein.)

SAND & GRAVEL, CRUSHED ROCK AND RIPRAP

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
481	Basin	Union Pacific Railroad, Union Pacific Bldg., Los Angeles	13	11N	6E	SB	Sand and gravel for use of Union Pacific Railroad; excavated from alluvial fan on south bank of Mojave River and about one-half mile southwest of Basin.
482	Brubaker-Mann roofing granule plant	Ronald Brubaker and William Mann, Star Route 1, Barstow	33	10N	1W	SB	Two miles northeast of Barstow. (Herein.)
	Declez						See Declezville.
483	Declezville (Declez) granite	Southern Pacific R.R., 610 S. Main St., Los Angeles. Leased to Columbia Construction Co., 8007 S. Western Ave., Los Angeles	35	1S	6W	SB	Northwest part of Jurupa Mts. (Aubury 06:48; Cloudman 19:896-897; Mackevett 51:13; herein.)
484	Fontana	Fontana Gravel Co., South Lime, Fontana	12	1S	6W	SB	(Herein.)
485	George Herz	George Herz and Co., Base Line and Lytle Creek, San Bernardino	31	1N	4W	SB proj.	(Herein.)
486	Holliday	Holliday Rock Products Co., P.O.Box 496, Colton	26	1S	5W	SB proj.	(Herein.)
487	Johnson Brothers	Johnson Brothers Co., 1945 W. 4th St., San Bernardino	8	1S	4W	SB proj.	(Herein.)
488	Mojave Rock Materials	Mojave Rock Materials Co., Box 434, Barstow	15	9N	1E	SB	(Herein.)

SAND & GRAVEL, ETC. (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Rattlesnake Gulch						See under limestone and dolomite.
489	Redlands	Redlands Sand & Gravel Co., No. Orange, Redlands	14	1S	3W	SB	(Herein.)
	San Bernardino	San Bernardino Rock and Gravel Co., San Bernardino	6	1S	4W	SB proj.	In Lytle Creek wash. Pit 1800 ft. long, 900 ft. wide and 20 ft. deep. Plant capacity 110 tons per hour.
490	Service	Service Rock Co., 2313 Hall Ave., Riverside	35	1S	5W	SB proj.	(Herein.)
	Sheerer (Sherer) granite	Clemens Scheerer, San Bernardino (1906)	29	6N	4W	SB	Southwest slope of Silver Mt. north of Victorville. Quarry opened in mid 1880's. Yielded rubble and riprap for Santa Fe R.R. between Victorville and Oro Grande. (Aubury 06:51; Crawford 96:622; Crossman 90:224-225.)
	Sherer granite						See Sheerer granite. (Crawford 96:622.)
491	Tom Woolsey roofing granule plant	Tom Woolsey, Box 171, South Pasadena	1	9N	1E	SB	In Yermo. (Herein.)
492	Triangle	Triangle Rock and Gravel Co., 2400 W. Highland Ave., San Bernardino	30	1N	4W	SB proj.	(Herein.)
493	Tri-City	Tri-City Rock Co., E. Third and Highland, San Bernardino	9	1S	3W	SB	(Herein.)
	White Lime Rock Company						White limestone crushed for roofing granules. See under limestone.

SILICA

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
494	Atlas	Mineral Materials Co., Alhambra	17	6N	4W	SB	Southwest end Silver Mountain east of Oro Grande. (Averill 51:357; herein.)
	Atlas Fire Brick Company ganister						See Kennedy.
	Brine and Weiss	Walter B. Weiss, Los Angeles and I.A. Brine Barstow					North of Barstow 20 miles. O tcrop of white silica 15 to 20 ft. wide reported 99.6 percent SiO_2. (Tucker 31:444.)
	Emsco ganister						See Golconda silica. (Tucker 30:302; 31:376-377, 444-445.)
495	Emsco quartzite	Southwestern Portland Cement Co., Victorville Operated by Emsco Refractories (Div. of Gladding McBean & Co.) 8601 Dorothy Ave., S South Gate	11	6N	4W	SB	East slope Silver Mt., 4 miles east of Oro Grande. Deposit opened after Golconda deposit abandoned prior to 1930. Quartzite unit along footwall of extensive limestone bed. Dips 40°, reported to contain 96 to 97 percent SiO_2. Quarry 300 ft. long, as deep as 75 ft. Used for refractory brick. (Tucker 30:302; 31:376-377, 444-445; 43:542-543, pl. 7.)
496	Golconda (Emsco ganister, Leahy ganister)	W.E. Leahy, 4238 Edgehill Dr., Los Angeles. Operated prior to 1930 by Emsco Refractories Co., E.M. Smith, pres., 5601 So. Boyle Ave., Los Angeles	36	9N	4W	SB	West of Hodge, 4 miles. Massive lens of quartzite; outcrop forms hill 500 ft. long, 200 ft. wide, 150 ft. high. At least several thousand tons quarried from openpit; exploration adit 60 ft. long in footwall. Abandoned by Emsco prior to 1930 when operations moved to quarry east of Oro Grande. See Emsco quartzite. (Tucker 30:302; 31:376-377, 444-445; 43:543.)
497	Ivanpah	Pomona Tile Mfg. Co., 629 N. La Brea Ave., Los Angeles. Leased to Western Talc Co., 1901 E. Slauson, Los Angeles	19, 30	14N	18E	SB	Castle Mts. Felsite. (Herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
498	Kennedy (Atlas Fire Brick Co. ganister)	John J. Kennedy, Daggett	31	9N	3W	SB	West of Hodge 4 miles. Similar to Emsco, on continuation of same quartzite body. Massive quartzite lens over 100 ft. wide; 3000 to 4000 tons of ganister used yearly for refractory brick. (1928) (Dietrich 28:97,194; Tucker 30:303; 31:374,377,445.)
	Keystone and Lucky Jim						See under feldspar.
	Leahy ganister						See Golconda. (Tucker 43:543, pl.7.)
	Lucky Betty	Jos. Irwing, 1639 E. 102nd St., Los Angeles, Clyde C. Downing, Reeves Aylmore, and W.F. Baldwin		Approx. 16N	13E	SB proj.	Southeast foothills of Clark Mts. 16 miles southwest of Roach, Nevada. Parallel pegmatite dikes in granite dipping 60° and 8 to 20 ft. wide are traceable $1\frac{1}{2}$ miles. Plant produced mica, silica and feldspar 1930. (Tucker 30:303-305; 31:377-379.)
	McKnight Cornishstone						See under feldspar.
499	Silica No. 1	Vernon W. Jay, Box 238, Barstow	15	13N	1E	SB	Southeast of Goldstone. Isolated knobs of quartz and granite pegmatite in weathered granite plain. Several hundred tons of white quartz mined in open quarries. Idle.
500	White Cloud	Mrs. Francis Cuddeback and Mrs. Hazel Cuddeback, Bakersfield. Leased to J.E. Lewis and L.P. Harper, Los Angeles (1941-1942)	35	29S	44E	MD	Granite Mts., 3 miles west of Copper City. Three parallel quartz veins, 10 to 20 ft. wide and dipping 50°, in granite. Assay reported 99.8 percent SiO_2. Developed by open cuts from which 100 tons were produced in 1941-1942. Idle. (Tucker 43:543, pl.7.)
	White Rock						See under feldspar.

TALC

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
501	A.C.	Sam Malinak, Tecopa; and L.B. Kingsly, 450 Por La Mar Drive, Santa Barbara	31	20N	7E	SB	Prospects southwest of Tecopa. (Herein.)
502	Acme	Southern California Minerals Co., 320 So. Mission Rd., Los Angeles	9, 10	19N	8E	SB proj.	In Alexander Hills east of Tecopa. Name sometimes applied to Western and Amargosa talc mines. (Tucker 43:545-546, pls. 6,7; herein.)
503	Amargosa (Acme)	Undetermined	34 3	20N 19N	7E 7E	SB SB proj.	South of Tecopa. (Tucker 20:367; 30:323; 31:399-400; herein.)
504	Anderson	Undetermined	35	17N	8E	SB proj.	Prospect in Silurian Hills. Talcose zone 200 ft. long, 10-15 ft. wide; appears mostly subcommercial.
505	Annex (Mammoth)	Silver Hills Mining Corp., 12707 Matteson Ave., Venice (1950)	35	17N	8E	SB proj.	In Silurian Hills. (Herein.)
506	Berryhill	Lloyd Williams, Tecopa (1950)	35	17N	8E	SB proj.	In Silurian Hills. (Herein.)
507	Blue White	Robert Fischer and Paul Scherman, Los Angeles	4	16N	9E	SB proj.	Prospect in Silurian Hills. Explored by adits 240 ft. long. Lenses of talcose rock, avg. 2 to 4 ft. wide, as much as 200 ft. long, border footwall of diabase sill.
508	Booth	Sierra Talc and Clay Co., 5509 Randolph St., Los Angeles	12	19N	8E	SB proj.	East end of Alexander Hills, east of Tecopa. (Tucker 43:546, pl. 7; herein.)
509	Brown	Western Talc Co., 1901 E. Slauson Ave., Los	28	20N	5E	SB	Prospects $3\frac{1}{2}$ miles west of Ibex Spring. Talcose zone dis-

TALC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
509	Brown (continued)	Angeles				proj.	continuously exposed for 2 miles, appears mostly sub-commercial.
510	Calmasil	Southern California Minerals Co., 320 So. Mission Rd., Los Angeles	4	15N	11E	SB	North of Yucca Grove. (Wright 50:125; 50:279; herein.)
	Calmasil Extension						See Halloran Spring.
511	Ceramic	Robert Fischer and Paul Scherman, Los Angeles	4	16N	9E	SB proj.	In Silurian Hills. (Herein.)
512	Crystal Spring	John Prato, 2134 W. Valley, Fontana	7 30	19N 20N	10E 10E	SB proj. SB proj.	West part of Kingston Range. (Herein.)
	Desert Talc and Clay						See Yucca Grove. (Tucker 43:546, pl.7.)
513	Excelsior	Southern California Minerals Co., 320 So. Mission Rd., Los Angeles	30, 31	20N	11E	SB proj.	East part of Kingston Range. (Tucker 43:546-547, pl. 7; Wright 50:126; 50a:278; herein.)
514	Gladding McBean	Gladding McBean and Co., 2901 Los Feliz Blvd., Los Angeles	4(?) approx.	15N	11E	SB	Northeast of Yucca Grove. Extension of Yucca Grove deposits.
	Gould						See Silver Lake.
	Great Wanamingo						See Halloran Spring.

TALC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
515	Grimshaw	E.L. Grimshaw and assoc. Tecopa	32	19N	6E	SB proj.	South of Ibex Sp. Talcose zones in altered carbonate rock. Talc bodies mostly less than 6 ft. thick. Prospected by several cuts, short adits and shallow shafts.
516	Halloran Spring (Calmasil) Extension, Great Wanamingo)	A.J. Rygh, 1409 Calumet Ave., Los Angeles	31	16N	11E	SB	Northwest of Yucca Grove. (Herein.)
517	Harry Adams	Harry Adams, 1406 Waterman, San Bernardino	10	20N	10E	SB proj.	Central part of Kingston Range. (Herein.)
518	Ibex (Moorehouse)	C.O. Gould Estate, Frank Clapp, Executor, 1107 So. Broadway, Los Angeles. Leased to Sierra Talc & Clay Co., 5509 Randolph St., Los Angeles	35	20N	5E	SB proj.	(Wright 50:278; 50:127; herein.)
519	Kingston No. 1	Frank Funk, Valley Wells. Leased to A.L. Smith, Box 41, Tecopa	5	19N	11E	SB proj.	East part of Kingston Range. (Herein.)
520	Kingston No. 8	E.M. Funk, Valley Wells	3,4	19N	10E	SB proj.	In central part of Kingston Range. Three prospect adits, all 50 ft. or less long, in talcose alteration zone. Material developed appears mostly subcommercial.
	Mammoth						See Annex. (Tucker 43: pl. 7.)
521	Monarch	Ralph Morris and associates Rm. 804, 612 So. Flower St., Los Angeles. Formerly leased to Sierra Talc and Clay Co., 5509 Randolph	35	20N	5E	SB proj.	Near Ibex Spring. (Engel 49:1033; Tucker 43:547, pl.7; Wright 50:278; 50:16; herein.)

TALC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
521	Monarch (continued)	St., Los Angeles					
	Moorehouse						See Ibex.
	Pacific Coast						See Silver Lake.
522	Patricia	Lloyd Williams, Tecopa (1950)	4	16N	9E	SB proj.	Prospect near Ceramic mine in Silurian Hills. Talcose lens several ft. wide; 30-ft. inclined shaft.
523	Pleasanton	Undetermined	35	20N	5E	SB proj.	Near Ibex Spring. (Herein.)
	Pomona						See Yucca Grove.
524	Pongo	H.C. Brown, 824 Lomita Rd., San Bernardino. Leased to Southern California Minerals Co., 320 So. Mission Rd., Los Angeles	15	19N	5E	SB proj.	(Herein.)
	Riggs and Best						See Silver Lake.
525	Rogers	F.B. Ortman, 2901 Los Feliz Blvd., Los Angeles	33 4	20N 19N	9E 9E	SB proj.	On west slope of Kingston Range. (Herein.)
526	Saratoga	H.C. Brown, 824 Lomita Rd., San Bernardino	26, 35	19N	5E	SB proj.	Near Saratoga Spr. (Herein.)
	Saratoga No. 1	H.C. Brown, 824 Lomita Rd., San Bernardino	26	19N	5E	SB proj.	South of Ibex Spring. Talc bodies in altered carbonate rock septa within diabase. Explored by short drift-adit. Small tonnage shipped in 1940's.

TALC (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
527	Sheep Creek	Avawatz Salt & Gypsum Co., Rm. 415 Pacific Mutual Bldg., Los Angeles. Leased to Sierra Talc & Clay Co., 5509 Randolph St., Los Angeles	5	17N	6E	SB proj.	Near Sheep Creek Spr. (Ladoo 23:116-117; Tucker 20:368-369; 30:324; 31:400; 43:547-548, pl. 7; herein.)
528	Silver Lake (Gould, Pacific Coast, Riggs and Best Tremolite)	M.E. Stearns estate, Los Angeles (16 claims) and Sierra Talc and Clay Company, 5509 Randolph St., Los Angeles (4 claims and one millsite.) Claims owned by Stearns estate are leased by Sierra Talc and Clay Company	21, 22, 23	16N	9E	SB proj.	Northeast of Silver Lake. (Cloudman 19:899; Diller 13:158-159; Engel 49:1026; Ladoo 23:116-117; Tucker 20:368-370; 30:325; 31:401; 43:548-549, pl. 7; Wicks 31:100-104; Wright 50:123-125; 50:278-279; herein.)
	Smith						See Tecopa.
529	Superior	Southern California Minerals Company, 320 So. Mission Rd., Los Angeles	25, 26	19N	5E	SB proj.	(Wright 50:227; 50:278; 52; herein.)
	Talc Products						Probably the present Berryhill mine, which see. (Tucker 20:369; 30:324; 31:400-401.)
530	Tecopa (Smith)	Sierra Talc & Clay Co., 5509 Randolph St., Los Angeles	35	20N	9E	SB proj.	West side of Kingston Range. (Tucker 43:549, pl. 7; Wright 50:127; herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Tremolite						See Silver Lake.
531	Van Talc	Undetermined	35	17N	8E	SB proj.	Southwest part of Silurian Hills. Prospect. Talcose zone 150 ft. long, 50 ft. wide; explored by 60-foot cross-cut and 30-foot drift.
532	Western (Acme)	Western Talc Co., 1901 E. Slauson Ave., Los Angeles	32, 33 4,5	20N 19N	3E 8E	SB SB proj.	Western part of Alexander Hills. (Tucker 20:267-268; 30: 324; 31:400; 43:545-546, pls. 6,7; Wright 50:123-127; 50: 278; herein.)
533	White Cap	Southern California Minerals Co., 320 So. Mission Rd., Los Angeles	26	19N	5E	SB proj.	(Wright 52; herein.)
534	Yucca	Undetermined	21	16N	10E	SB proj.	(Herein.)
535	Yucca Grove (Desert Talc and Clay, Pomona)	Pomona Tile Mgf. Co., 639 N. La Brea Ave., Los Angeles	4	15N	11E	SB	North of Yucca Grove. (Tucker 43:546; Wright 50:125; 50: 279; herein.)

MISCELLANEOUS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Allison garnet		30	6N	13E	SB	Northeast of Amboy on Snowcap limestone deposit.Contains garnet. Reported to be suitable for abrasive use. (Tucker 30:307; 31:381.)
	Iron Hat (Lena Louise) garnet						See under iron. Lamey reports commercial production of garnet was attempted on a very small scale. (Lamey 48:107; Tucker 30:307; 31:382.)
	Lena Louise garnet						See Iron Hat. (Tucker 30:307; 31:382.)
569	Marter-White	Marter Mining Co., 530 W. 6th St., Los Angeles	27, 34	7N	4W	SB	East of Oro Grande. (Cloudman 19:861-862; Tucker 21:338; 30:301; 31:375; 43:511-512, pl.7; herein.)
570	Victorite pyrophyllite	Mineral Materials Co., 1145 Westminister Ave., Alhambra	24, 25	7N	3W	SB	Southwest of Stoddard Mts. (Herein.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
536	American Borax (Columbia, Owens)	American Borax Co., Daggett (1907)	25 30	10N 10N	1W 1E	SB SB	Calico district. Described in borate section herein. (Bailey 02:60; Crawford 94:35.)
	American Potash and Chemical Corp.						See Trona in section on potassium salts.
	American Trona Corp.						See Trona in section on potassium salts. Predecessor of American Potash and Chemical Corp. (Cloudman 19:511,854, 894; Gale 13:312; Newman 23:222; 23:31, 32; Teeple 29: 23, 24; Tucker 20:357,358; Ver Planck 50:213.)
	Blumenberg						Probably a synonym for the Palm Borate property, which see. (Bailey 02:59)
	Calico						Name commonly applied to colemanite property formerly operated by the Pacific Coast Borax Company in the Calico district. See Pacific Coast Borax Company.
	California Trona Co.						Predecessor of American Trona Corp. and American Potash and Chemical Corp. Active 1908-1909 in unsuccessful attempt to recover trona from trona reef and from brine of Searles Lake. (Gale 13:309; Teeple 29:21-23; Ver Planck 50:213.)
537	Centennial	Undetermined	29	10N	2E	SB	Calico district. Described in borate section, herein.
	Columbia	Columbia Mining and Chemical Co., Daggett (1902)	25 30	10N 10N	1W 1E	SB SB	Calico district. Probably predecessor of American Borax described in borate section. (Bailey 02:60)
538	Columbus (Gem)	Columbus Borax Co., Daggett (1917)	9, 10	8N	1E	SB	Described in borate section herein.
	Gem						See Columbus.

BORATE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Oasis	Oasis Mining and Oil Co. (1902)					Noted by Bailey as shaft $1\frac{1}{2}$ miles northwest of Marion. (Bailey 02:60.)
	Owens						Noted by Crawford. Probably the property later worked by American Borax Co. as described in borate section herein. (Crawford 94:35.)
539	Pacific (Pacific Coast Borax Co. workings)	Pacific Coast Borax Co., (1907)	18,19, 20 23,24 25	10N 10N	2E 1E	SB SB	In Calico district. Formerly operated by Pacific Coast Borax Co. See borate section herein. (Bailey 02:58-59; Cloudman 19:353; Crawford 94:35; Crossman 90:225; Storms 92:345-349; Tucker 30:316; 31:392; Ver Planck 50:216,217)
540	Palm Borate	Palm Borate Co. (1907)	19, 20, 29, 30	10N	2E	SB	Described in borate section herein. Probably referred to by Bailey (Bailey 02:59) as Blumenberg mine.
541	Saratoga Beds	Undetermined	3	18N	5E	SB	Efflorescent borate deposits near Saratoga Springs. Prospected but not worked. (Bailey 02:63; Cloudman 19:856.)
	Searles Borax Marsh						See Searles Lake.
542	Searles Lake (Searles Borax Marsh)			25S 26S 25S 26S	43E 43E 44E 44E	MD MD MD MD	Source of brine for current operations at plants of American Potash and Chemical Corp. and West End Chemical Co. See also American Trona Corp. Borosolvay, California Trona Co., Trona and section on salines herein.
	Stevens and Greer	Undetermined					Calico district. An early borate shale operation with holdings on south side of Calico Range. Begun prior to 1904. Holdings may have included deposits listed elsewhere in this section. (Crawford 94:35.)
	Trona (American Potash and Chemical Corp.)						See section on potassium salts.

BORATE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
543	Union Borax Co. shaft	Union Borax Co., a subsidiary of Standard Sanitary Company, Pittsburg, Penn. (1920)	19	10N	2E	SB	Calico district. See borate section herein.
	West End						Searles Lake. See West End in sodium carbonate section.
544	Western	Western Mineral Co. (1902)	22	10N	1E	SB	Calico district. Described in borate section herein. (Bailey 02:59,60.)

BROMINE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Trona (American Potash and Chemical Co.)						See Trona in potash section herein.

CALCIUM CHLORIDE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bristol Lake						See California Salt Co. under salt, and Hill Brothers Chemical Co. and National Chloride Co. of America in this section. (Gale 51:21 pp; Hewett 36:94; King 48:190.)
545	Cadiz Lake	Lee L. Bardsley, Amboy. Leased by Hill Brothers Chemical Co., 2159 Bay St., Los Angeles		2N 3N	15E 15E	SB SB	Cadiz Lake brine has a high concentration of calcium chloride and is similar to the Bristol Lake brine. Drill holes as deep as 30 ft. used to prospect the area held by Bardsley in the center of the lake bed. Brine in most holes has been found at depths of 7 or 8 ft. and usually under a bed of salt which averages 3 ft. in thickness. Recovery operations are planned. (Hewett 36:95; King 48:190.)
	California Salt Company						See under salt.
	Desert Properties Company						See National Chloride Co. of America. (Gale 51:9.)
546	Hill Brothers Chemical Company	Hill Brothers Chemical Co., 2159 Bay Street, Los Angeles	11	5N	12E	SB	Bristol Lake. (Gale 51:9; herein.)
	Hollar Chemical Company						See National Chloride Co. of America. (Gale 51:9; Tucker 43:540, pl. 7.)
	Kramer Consolidated Oil Company dry hole	Undetermined	11	10N	5W	SB	Near Hawes. Well drilled for oil. Abandoned 1908 at depth of 2940 ft. in dolomitic limestone. Water above 2000 ft. cased off. Analysis of water sample, taken in 1917, showed that calcium chloride was a major constituent of the total dissolved solids. (Thompson 29:277-278.)
547	National Chloride Company of America (Desert Properties Co., Hollar Chemical Co., Saline Products Co.)	National Chloride Co. of America, 354 So. Spring St., Los Angeles	1-15 incl. 7,8 29-36 incl.	4N 4N 5N	12E 13E 12E	SB SB SB	On Bristol Lake. Has produced salt. (Gale 51:9-10; Tucker 30:321; 31:397; 43:540; pl.7. herein.)

CALCIUM CHLORIDE (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Saline Products Company						See National Chloride Co. of America. (Gale 51:9; Tucker 30:321; 31:397.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
548	Amboy (Bristol Dry Lake, Consolidated Pacific, Pacific Consolidated)	U.S. Gypsum Co., Chicago, Illinois	3,4, 8,10, 11,17, 19,20, 29,30	5N	12E	SB	Bristol Lake. Deposits worked by Consolidated Pacific Cement Plaster Co., 1907-1924. Idle since. See saline section herein. (Cloudman 19:869; Gale 51:1-21; Hess 10:25-27; Stone 20:81-82; Thompson 29:689-704; Tucker 20:352; Ver Planck 50:225; 51:120; 52:47,59; herein.)
549	Avawatz	Avawatz Salt & Gypsum Co., 2545 Raleigh Dr., San Marino	30	18N	6E	SB proj.	Avawatz Mountains. (Newman 23:232; Phalen 12:526-531; Stone 20:82, 83; Tucker 20:352; 30:307; 31:382; Ver Planck 50:226; 51:120; 52:43-44, 60-61; herein.)
			5, 6,8	17N	6E	SB proj.	
			1,2, 3	17N	5E	SB proj.	
			16,19, 20,21, 22, 23,26, 27,28, 29,34, 35,36	18N	5E	SB proj.	
	Bristol Dry Lake						See Amboy.
	Cady	William Hale, 310 "D" St., San Bernardino (1906)		10N	5E	SB	Reported by Aubury as near Old Camp Cady. A prospect. (Aubury 06:287.)
	Consolidated Pacific (Pacific Consolidated)						See Amboy. (Cloudman 19:869; Hess 10:25-27; Stone 20:81, 82.)
	Couchman						Probably same as Red Canyon deposit described herein. (Tucker 30:307; 31:382; 43:516.)
550	Danby Dry Lake	Undetermined	7	1N	19E	SB	Selenite-bearing playa lake beds along SE. margin of Danby Dry Lake. (Aubury 06:287; Noble 31:57,58, Ver Planck

GYPSUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
550	Danby Dry Lake (continued)						52:48.)
	M. Mulcahy	M. Mulcahy, Daggett (1919)					In Calico district $2\frac{1}{2}$ miles west of Yermo. Impure gypsum bed, 2 to 4 feet thick, associated with borate-bearing Tertiary strata. (Cloudman 19:870.)
551	Owl Hole	Undetermined	22	18N	3E	SB	Near Owl Hole Spring. Pliocene(?) gypsum-bearing lake beds. Gypsum occurs as beds mostly less than 2 ft. thick. Associated with salt-impregnated shale containing celestite nodules. (Ver Planck 52:39.)
	Pacific Consolidated						See Amboy.
552	Red Canyon	Jerry Korfist and Frank Curtis, Baker	17	17N	10E	SB	Probably same as Couchman deposit which see. (Herein.)
553	Shire	D.H. Shire, 323 W. Florence, Los Angeles	36 24 approx.	18N $17\frac{1}{2}$N	13E 13E	SB SB	Northeast of Clark Mt. (Ver Planck 52:25-27; herein.)

LITHIUM

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
554	Trona						See Trona in potassium salts section.

MAGNESIUM SALTS

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
555	American Magnesium Company (Wright)	Undetermined	29, 32	25S	47E	MD proj.	West of Owlshead Mts. Hydrous magnesium sulfate (epsomite), and hydrous aluminum sulfate (alunogen), in Tertiary clay beds. A monorail railroad, 28 miles long, was constructed from Searles Lake to the deposit during 1922-24. A plant was built at the southwest end of Searles Lake 6 miles south of Trona. The project was abandoned in 1927. (Hewett 36:96; Jahns 51:18-21; Newman 23:742; 23:31-32; Tucker 30:316; 31:392; 43:536, pl.7.)
	Wright						See American Magnesium Co. (Hewett 36:96.)

NITRATE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Various localities						Various locations discussed in the literature under the following names: Barstow, Calico, Coolgardie, Danby, Leach, Lower Canyon Beds, Needles, Owl Springs, Pilot, Round Mountain, Salt Springs, Saratoga, Twentynine Palms, Upper Canyon Beds, and Valley. Nitrate-bearing material of commercial grade has not been found at any of these localities. (Bailey 02:43,159,167,171,174-180; Cloudman 19:890-891; Noble 22:1-99; 31:1-108; Tucker 30:316; 31:392.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	American Potash and Chemical Corporation						See Trona.
	American Trona Company						Predecessor of American Potash and Chemical Corp. See Trona.
	Borosolvay	Solvay Process Company, Borosolvay	30	25S	43E	MD	Plant recovered potash salt from Searles Lake 1916 to 1920. Since idle. (Hamilton 22:62; Tucker 20:358; 30:318; 31:394; Teeple 29:24,25; Ver Planck 50:213.)
	California Trona Company						Predecessor of American Potash and Chemical Corp. See Trona.
556	Trona (American Potash and Chemical Corporation)	American Potash and Chemical Corp., 70 Pine St., New York, N.Y.		25S 26S 25S 26S	43E 43E 44E 44E	MD MD MD MD	Searles Lake. Includes area and installations formerly held by California Trona Co. and American Trona Co., which see. (Bradley 45:362; Dolbear 13:256-261; Gale, H.S. 15:251-323; May 49:1-10; Ryan 51:447-452; Teeple 29:[illegible]-63; Tucker 30:316-318; 31:392-394; 43:537,540; Ver Planck 50:211-214,217,221,233-237,240-241,247,250; 51:76,77; herein.)

SALT

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
557	Avawatz		27	18N	5E	SB proj.	Avawatz Mts. See description under gypsum in text herein. Salt deposits explored 1941-42 by Basic Magnesium, Inc. revealing large reserves of salt. (Bailey 02:126-128; Cloudman 19:892,893; Phalen 14:526-531, 19:186-187; Tucker 21:356-357; 30:319-320; 43:538, pl.7.)
558	Avery (Evans)	Title Insurance & Trust Co., for Russ Avery and Assoc., 2700 W. 3rd St., Los Angeles	16,21	2N	17E	SB	Danby Lake. Patented land totaling 660 acres. Site of operations of Crystal Salt Co. and of famous salt house. (Bailey 02:104,128-129; Cloudman 19:893; Tucker 21:357; 30:320; 31:396; 43;539-540.)
	Bitter Springs			14N	5E	SB	Southeast end of Bitter Lake. Water contains salt and sodium sulfate. (Bailey 02:128; Phalen 19:189.)
	Cadiz Dry Lake			2N 3N	5E	SB	See discussion of Cadiz Dry Lake in general saline section in text herein. Brine being tested for possible calcium chloride recovery operation by Hill Brothers Chemical Co. (Tucker 30:320; 31:396; 43:538, pl. 7.)
	California Rock Salt Co.						See California Salt Company. (Newman 23:613; Tucker 30:320; 31:396; 43:539, pl.7.)
559	California Salt Company (California Rock Salt Co., Consumers Salt Co.)	California Salt Co., W.F. Biedebach, pres., 2436 Hunter St., Los Angeles	11-15, 20, 22-24, 27-29, 32-35 incl.	5N	12E	SB	Bristol Lake. Also produces calcium chloride brine. (Cloudman 19:893; Newman 23:613; Phalen 19:185; Tucker 21:357; 30:320; 31:396; 43:539, pl. 7.; herein.)
	Consumers Salt Co.						See California Salt Company. (Cloudman 19:357.)
	Daggett						Beds of salt "a few miles from Daggett" worked in late 1800's by silver miners from Calico district. (Bailey 02:128; Phalen 19:189.)

SALT (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Danby Dry Lake	Various		1N 2N 2N	18E 17E 18E	SB SB SB	See discussion of Danby Lake in general saline section in text herein. See also Avery, Metropolitan Water District, and Reeder. Salt recovered in late 1800's by the Crystal Salt Co. and sold to silver mills in Arizona for chloridizing. Some shipped to San Francisco. (Bailey 02:104,128-129; Cloudman 19:893; Phelan 19:187; Tucker 21:357; 30:320; 31:396; 43:539-540, pl.7.)
	Evans						See Avery. (Cloudman 19:893.)
	Hollar Chemical Co.						Bristol Lake. See National Chloride Co. under calcium chloride. (Tucker 43:540, pl.7.)
560	Metropolitan Water District	Metropolitan Water District, 306 3rd Street, Los Angeles	22, 23,24, 25,26	2N	17E	SB	Danby Dry Lake. District has application for leases on 1,680 acres. Exploration work and pilot plant erected 1939-1941. No production.
	Milligan Salt Co.						See Danby Dry Lake. (Cloudman 19:893-894.)
	Owl Spring district						Northwest of Avawatz Mts. Probable extension of Avawatz Tertiary lake bed series. (Bailey 02:130; Phalen 19:189.)
561	Reeder	Reeder Salt Co., W.C. Reeder, 845 E. Centre, South Pasadena	35 1,2,3, 10,11, 12,13, 14,15, 22,23	2N 1N	18E 18E	SB SB	Danby Lake. Holdings total over 4000 acres. (Tucker 43:539-540, pl.7.)
	Saline Products Co., Inc.						Bristol Lake. See National Chloride Co. under calcium chloride. Produced salt and calcium chloride from Bristol Lake. (Tucker 30:721; 31:397.)

SALT (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Searles Lake						Large tonnages of salt are discarded in operations of American Potash and Chemical Co. and Westend Chemical Co. See under potash and soda ash.
	Soda Lake						South of Baker. Some salt has been produced here in small solar evaporation operations. Also a possible source of sodium sulfate. (Bailey 02:130; Phalen 19:187-189.)

SODIUM CARBONATE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION				REMARKS
			SEC.	T.	R.	B & M	
	Trona						See Trona in potash section.
562	West End	West End Chemical Co., 608 Lathum Square Bldg. Oakland	24,25, 26,27, 31,33, 34,35, 36	25S	43E	MD	Plant on southwest edge of Searles Lake. (Newman 23:32; Tucker 30:322, 323; 31:399; 43:542; Ver Planck 50:214; Wiseman 51:1-15; herein.)
			30,31	25S	44E	MD	
			5, 6	26S	44E	MD	

SODIUM SULPHATE

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	Bitter Springs						See under salt.
	Black Basin	C.W. Lipman, Story Bldg., Los Angeles (1930)		Approx. 12N	11E	SB	Prospect in Old Dad Mts. (Tucker 30:322; 31:398.)
	Burts Lake						Old name for Dale Dry Lake, which see. (Bailey 02:66.)
563	Dale Dry Lake (Burts Lake)	Dale Chemical Industries, Inc., 61 Broadway, N.Y., and Twentynine Palms	23,26, 27,34, 35	1N	12E	SB	East of Twentynine Palms. Salt also produced. (Bailey 02:66; Hewett 36:95; King 48:190,192,198; Tucker 30:321-322; 31:397-398; 40:63:43:129-130,540-541, pl.7; herein.)
564	Danby Lake	Arthur Doran, Barstow, and Tom Schofield, Danby	33,34	2N	18E	SB	Danby Lake just west of Saltmarsh. Small, mushroom-shaped accumulation of crystalline sodium sulfate on bed of dry lake. Owner reports 90 to 100 cars mined and shipped in early 1920's.
	Emerson Dry Lake	Mrs. L.S. Emerson, Hodge (1930)		4N 4N	5E 6E	SB SB	Dry Lake district 60 miles east of Victorville. Thin crysts and bedded deposits. Undeveloped. (King 48:198: Tucker 30:322; 31:398.)
	Soda Lake			12N 12N 13N 13N	8E 9E 8E 9E	SB SB SB SB	The sink of the Mojave River. Noted by King as being a potential source of saltcake. (King 48:190,192,198; Phalen 19:187-189.)
	Trona (American Potash and Chemical Corp.)						See under potash. Sodium sulfate produced at rates as high as 600 tons per day.

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
565	Argos (includes properties variously described as L.A. Davis, Du Pont, Ludlow, and Rowe and Buehler)		19,30 25	8N 8N	7E 6E	SB SB	South side of Cady Mts. Described in strontium section herein. (Durrell 47:1250; Hewett 36:155-157; Mallery 16:952; Moore 16:952; Tucker 40:254; 43:455; Ver Planck 50:271.)
566	Avawatz	Avawatz Salt & Gypsum Co., 2545 Raleigh Dr., San Marino	16,21, 22,27	18N	5E	SB proj.	North of Avawatz Mts. Celestite-beds, 6 ft. in max. thickness, exposed for lateral distances of about 1000 ft. In Tertiary lake deposits associated with gypsum and gypsiferous clay. Unit containing celestite beds generally from 20 to 30 ft. thick, thins at both ends. Celestite nodules along continuation of zone for several thousand ft. northwest. (Hewett 36:158-160; Moore 35:365-368; Phelan 12:526-531; Tucker 21:367; 30:323; 31:399; 43:543-544, pl.7; Ver Planck 50:271.)
567	Barstow (T.G. Nicklin)	L.G. Henderson and T.G. Nicklin, Barstow, (1935)	29,30	11N	1W	SB	Northeast of Barstow. Beds and nodular concretions of strontianite in several hundred-foot thickness of shaly tuffs and clays of the Barstow formation. Strontianite exposed in belt about 2 miles long. Most bodies less than one cubic yard in volume. Active briefly during World Wars I and II; difficult to mine acceptable grade. (Hewett 36:160; Knopf 18:257-270; Moore 35:375-377; Ver Planck 50:271.)
568	Bristol Lake	A.C. Becker and L. Stevenson, Los Angeles (1943)	4,7,8	4N	12E	SB	Nodular, potatoelike masses of celestite in muds near surface of Bristol Dry Lake. Particularly abundant along south margin. Unsuccessful attempt in 1942 to recover by plowing. (Gale 51:10; Tucker 43:544, pl.7; Ver Planck 50:272.)
	L.A. Davis						An early location. Probably on Argos celestite deposits. See Argos. (Cloudman 19:853, 898.)

STRONTIUM (Cont.)

MAP NO.	CLAIM, MINE, OR GROUP	OWNER NAME, ADDRESS	LOCATION SEC.	T.	R.	B & M	REMARKS
	DuPont	E.I. duPont de Nemours, Wilmington, Delaware					Claims on part of Argos celestite-bearing zone. See Argos. (Tucker 40:254; 43:544, 545, pl.7.)
	La Douceur	James La Douceur and Ralph Overhold, 3577 McNally Avenue, Altadena	NW$\frac{1}{4}$ 30	8N	7E	SB	Claims on part of Argos celestite-bearing zone. Formerly part of Rowe and Beuhler holdings. See Argos.
	Ludlow						Operation on Argos celestite zone; active in 1918. See Argos. (Tucker 21:367.)
	T.G. Nicklin						See Barstow. (Cloudman 19:899.)
	Owl Hole Springs	Undetermined		17N	3E	SB	Celestite nodules in clay. (Ver Planck 50:272.)
	Rowe and Beuhler	Wesley N. Rowe, 1451 So. Delta St., Rosemead and Wm. C. Buehler, 1555 Sunset Ave., Pasadena	SE$\frac{1}{4}$ 19	8N	7E	SB	Claims on part of Argos celestite-bearing zone. Several shallow pits and trenches. Celestite bess as much as 6 in. thick and several hundred feet long. See Argos. (Tucker 40:254; 43:545, pl.7.)

STATE OF CALIFORNIA
GOODWIN J. KNIGHT, Governor
DEPARTMENT OF NATURAL RESOURCES
DeWITT NELSON, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO
OLAF P. JENKINS, Chief

De ARGENTO VIVO

Historic Documents on Quicksilver and Its Recovery in California Prior to 1860

Assembled by
ELISABETH L. EGENHOFF

As a Supplement to the
California Journal of Mines and Geology for October 1953

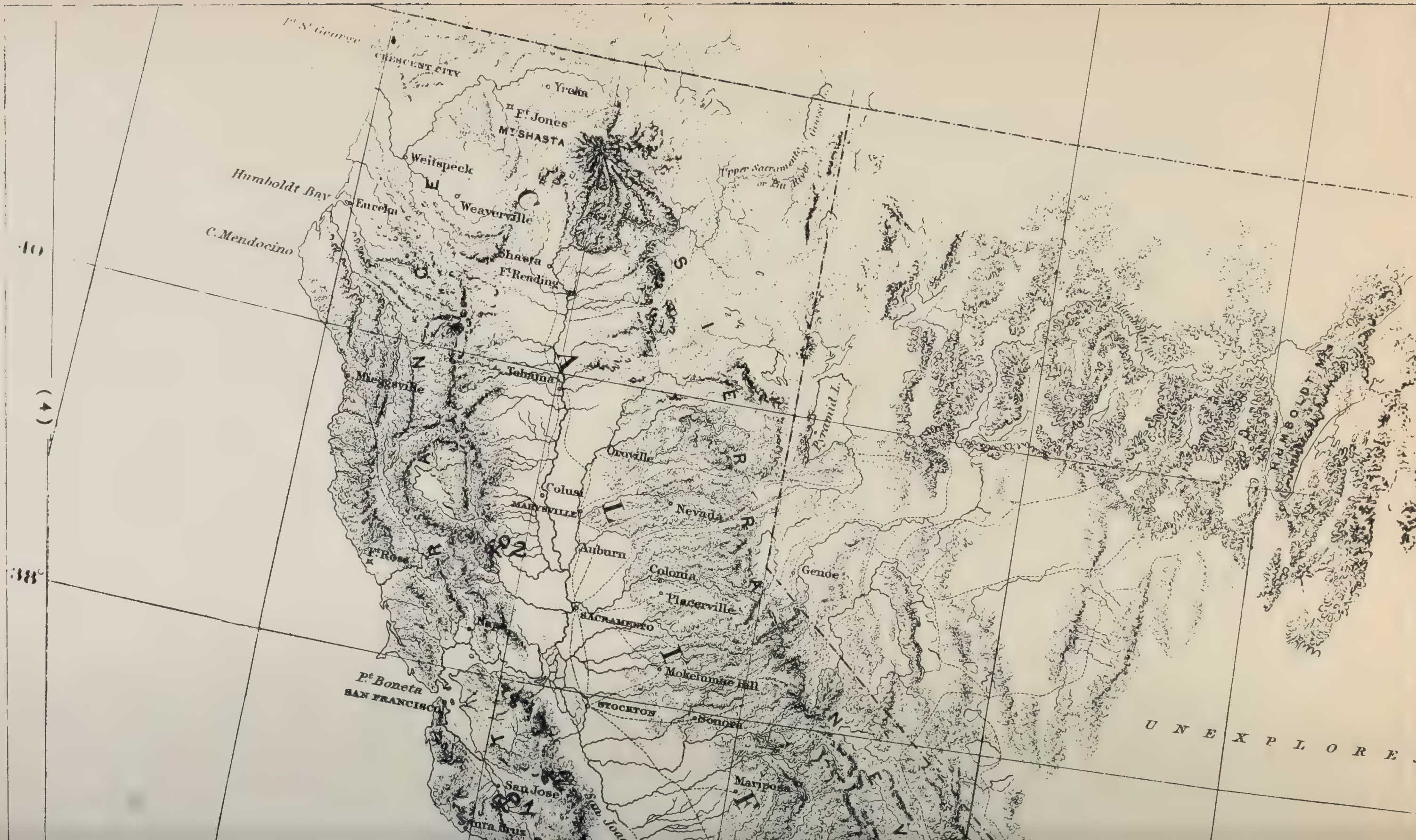
FOREWORD

Since first he made its acquaintance, quicksilver, the *argentum vivum* or living silver, has intrigued the imagination of man. Early in his career as miner and metallurgist, he learned to fear its evil influence upon his health: yet as doctor he used it liberally in his medicines. Awed by its volatile nature, and by its ability to change form, he gave it the name of the god Mercury, and the sign of the god's own planet. During the Dark Ages he even went so far as to grant it religious and philosophical recognition, tying it into the cycle of life and death, and the creation of matter: the philosopher's living silver, for which alchemists spent their lives searching, but never found, was conceived to be a perfect thing, the seed capable of producing with sulfur, all kinds of metals, according to the manner in which it was mixed with less perfect things. Thus, for many years quicksilver was considered to be a half natural, half supernatural element; not until the sixteenth century, when alchemy began to give way to chemistry and metallurgy, did the true nature of the unique substance, its capabilities and limitations, become generally known.

De Argento Vivo, a chronicle of quicksilver and its mining in California prior to 1860, contains first, extracts from writings on quicksilver that date from 300 B.C. to the three-quarter point of the sixteenth century; second, pictures and extracts from writings on the discovery and mining of quicksilver in California that date from the last quarter of the eighteenth century to the middle of the nineteenth century. It is the third in the Division of Mines series of documents on the history of discovery and development of mineral materials in the State. The first of the series, *The Elephant As They Saw It*, covers the history of gold mining to 1862; the second, *Fabricas*, covers the use of mineral materials in building prior to 1850.

I should like to express sincere appreciation to Miss Mary Rae Hill of the Editorial Section of the Division of Mines for her assistance in making this compilation, and for taking most of the photographs that accompany the text; and to the California State Library in Sacramento, Bancroft Library and General Library of the University of California, Huntington Library in San Marino, California Historical Society in San Francisco, and Society of California Pioneers in San Francisco, for making available for publication the material in their files.

ELISABETH L. EGENHOFF
Editor, Division of Mines
June 5, 1953.



CRESCENT CITY
Yreka
Ft. Jones
Mt. SHASTA
Weitspeck
Humboldt Bay
Eureka
Weaverville
C. Mendocino
Shasta
Ft. Reading
Upper Sacramento or Pitt River
Tehama
Mendocino
Pyramid L.
Oroville
Colusa
MARYSVILLE
Nevada
Auburn
Ft. Ross
Genoe
Coloma
Placerville
SACRAMENTO
Napa
Mokelumne Hill
Pt. Boneta
SAN FRANCISCO
STOCKTON
Sonora
Mariposa
San Jose
Santa Cruz
HUMBOLDT MTS.
UNEXPLORED
40
38°

FRONTISPIECE MAP

FRONTISPIECE MAP

The frontispiece map is a portion of the *Map of the United States and their territories . . . Compiled from surveys made under the order of* W. H. *Emory, 1857-8 . . .* in *Report on the United States and Mexican Boundary Survey.* To it have been added symbols showing the location of the New Almaden and Redington quicksilver mines, whose discoveries are documented in *De Argento Vivo.* The New Almaden mine was selected for documentation from the many mines of quicksilver in California because the first verified discovery of quicksilver in the State was made at New Almaden; the Redington was chosen because it was one of the important early-day quicksilver mines north of San Francisco Bay, with a most interesting story of discovery.

The first mining for quicksilver in California—and in the United States—was at the New Almaden mine. After 1850 several other mines were discovered and worked, but until 1865 New Almaden was responsible for the lion's share of the production, furnishing the quicksilver used in placer gold mining for amalgamating gold in the pans, rockers, and long toms. In 1865, New Idria, Redington, Aetna, and a number of smaller properties started comparatively large-scale production; between 1874 and 1879 the highest point in California quicksilver-production history was reached, largely as the result of the invention and successful use of the Scott fine-ore furnace at New Almaden in 1877, the widespread use of the pan-amalgamation process for the treatment of gold ores, and the boom in hydraulic mining. In 1877, the peak year, almost 80,000 flasks of quicksilver was produced.

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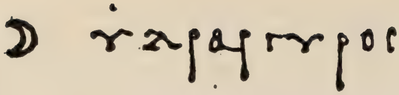

CHAPTER I

IN WHICH ARE SET FORTH DISCOURSES UPON NATIVE AND FACTITIOUS CINNABAR

BY

ANTIENTS OF GREECE AND ROME

Quicksilver . . . was at first regarded as a sort of counter-silver, and was represented by the sign of the moon, reversed. M. Berthelot, 1889.

THEOPHRASTUS OF LESBOS

On the Two Kinds of Cinnabar

B.C. 300(?)

Englished by JOHN HILL, A.D. 1746

The liquid element mercury, or quicksilver, was undoubtedly known long before the time of Theophrastus. Archaeologists are convinced that the ancient Egyptians were familiar with tin and copper amalgams, and that the Phoenicians and Carthagenians were acquainted with the element as early as 700 B.C. A small vessel of quicksilver found in a grave at Kurna in Mesopotamia has been dated 15th or 16th century B.C. In China, there are records of the use of vermilion ink and paint, as well as the fluid metal, about 200 B.C. The first written mention of quicksilver, or liquid silver, is by Aristotle (320 B.C.), who described it as containing much air and water, and referred to its use by the priests.

Theophrastus, quoted herein, was a native of Eresus, in Lesbos, and a pupil of Aristotle. The exact date of his birth is not known, but was probably between 373 and 368 B.C.; he died in 288 B.C. A portion of the Greek text of his *On Stones,* written about 300 B.C., is reproduced herein with English translation and notes from *Theophrastus' History of Stones. With an English Version, and Critical and Philosophical Notes . . . by John Hill . . . London . . . MDCCXLVI.*, in the collection of the Library of the University of California, Berkeley, California.

ΘΕΟΦΡΑΣΤΟΥ τοῦ ΕΡΕΣΙΟΥ
ΠΕΡΙ ΤΩΝ
ΛΙΘΩΝ
ΒΙΒΛΙΟΝ.

THEOPHRASTUS's
HISTORY of STONES.

With an ENGLISH VERSION,

AND

CRITICAL and PHILOSOPHICAL NOTES,

Including the Modern Hiſtory of the GEMS, *&c.* deſcribed by that Author, and of many other of the Native FOSSILS.

By *JOHN HILL.*

To which are added,

TWO LETTERS:

One to Dr. JAMES PARSONS, F.R.S.
On the Colours of the *Sapphire* and *Turquoiſe.*

AND THE OTHER,

To MARTIN FOLKES, Eſq; Doctor of Laws and PRESIDENT of the ROYAL SOCIETY;

Upon the Effects of different Menſtruums on *Copper*

Both tending to illuſtrate the Doctrine of the GEMS being coloured by *Metalline Particles.*

LONDON,
Printed for C. DAVIS, againſt *Grays-Inn* in *Holborn*, Printer to the ROYAL SOCIETY.
MDCCXLVI.

ργ'. Γίνεται δὲ καὶ Κιννάβαρι· τὸ μὲν αὐτοφυὲς, τὸ δὲ, κατ' ἐργασίαν°. αὐτοφυὲς μὲν, τὸ περὶ Ἰβηρίαν,

* The Antients, we find, had what they called the native and factitious Cinnabar as well as we; their native Cinnabar was the same with ours, but the factitious very widely different. Theirs was, we see, no other than a Preparation of a fine shining arenaceous Substance, which was the *Sil Atticum Romanorum* injudiciously confounded by *Vitruvius* with the *Ochra Attica* of the Antients; whereas ours is a Substance formed, by the Art of Chemistry, of Quicksilver and Sulphur, into a dense heavy Mass, of a bright red, marked with shining silvery Streaks.

The native Cinnabar of the Antients and of the Moderns are, however, the same; and theirs, as well as ours,

CIII. There are also two kinds of Cinnabar, the one native, the other factitious°; the native, which

was a dense heavy mineral Substance, of a shining red Colour; from which Quicksilver was extracted. This Substance was also called *Minium*; and, in After-times, becoming subject to Adulterations with Lead Ore calcined to a Redness, after the two Names had long been used in common, the Word *Minium* became at last appropriated to the calcined Lead Ore only; and the Cinnabar was used only to signify what we now understand by it, the Substance from which Quicksilver was to be extracted.

The Word Cinnabar κιννάβαρι, however, among the old Writers in Medicine, frequently is used to signify a Thing of a very different Kind, a vegetable Juice, called by us

σκληρὸν σφόδρα καὶ λιθῶδες· ἔστι τὸ ἐν Κόλχοις. τοῦτο δέ φασιν εἶναι κρημνῶν. ἐγκαταβάλλουσι τοξεύοντες. τὸ δὲ κατ' ἐργασίαν ὑπὲρ Ἐφέσου μικρὸν ἐξ ἑνὸς τόπου. μόνον δ' ἐστὶν ἄμμος, ἣν συλλέγουσι λαμπυρίζουσαν, καθάπερ ὁ κόκκος· ταύτην δὲ τρίψαντες ὅλως ἐν ἀγγείοις λιθίνοις λειοτάτην πλύνουσιν ἐν χαλκοῖς, μικρὸν ἐν κάλοις. τὸ δ' ὑφιστάμενον πάλιν λαβόντες, πλύνουσι καὶ τρίβουσιν. ἐν ᾧπερ ἐστὶ τὸ τῆς

Dragons-blood; and long idly believed to be really the Blood of Dragons. This generally was, however, called Κιννάβαρι Ἰνδικὸν, from its Country, to diſtinguiſh it from the other, or mineral Cinnabar, γίνεται δὲ ἐν αὐτῇ καὶ Κιννάβαρι τὸ λεγόμενον Ἰνδικὸν, ἀπὸ τῶν δένδρων ὡς δάκρυ συναγόμενον, *Dioſcorides.*

This Cinnabar they therefore knew as a perfectly diſtinct Subſtance, though called by the ſame Name. And the mineral native Cinnabar, the thing here ſpoken of, was, we find, a hard ſtony Subſtance: Ours is a compact weighty Body, found ſometimes pure, and ſometimes incorporated with different other Subſtances, or containing other Subſtances incorporated with it.

The pure Cinnabar is generally of a bright red, ſometimes deeper, ſometimes paler, but commonly ſparkling or gloſſy; ſome is found of a deeper and duſkier Colour in the Maſs, but becomes of a fine Red when rubbed to Powder: And ſome of it reſembles the Hæmatites of ſome Kinds.

When incorporated with other Subſtances, it is chiefly found in Spar, or in looſe, arenaceous or ſparry Stones; ſometimes, but much more rarely, in clayey Earth, and ſometimes in a talky Matter, greyiſh, or bluiſh, or whitiſh.

is found in *Spain*, is hard and ſtony; as is alſo that brought from *Colchis*, which they ſay is produced there in Rocks and on Precipices, from which they get it down with Darts and Arrows. The factitious is from the Country a little above *Epheſus*; it is but in ſmall Quantities, and is had only from one Place. It is only a Sand, ſhining like Scarlet, which they collect, and rub to a very fine Powder, in Veſſels of Stone only; and afterwards waſh in other Veſſels of Braſs, or ſometimes of Wood: What ſubſides they go to work on again, rubbing it and waſhing it as before. And in this Work there is much Art to be uſed; for from an equal Quantity of the Sand ſome will make a large Quantity of the

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It frequently holds incorporated with it, beſide Quickſilver, Gold, Silver, ſparry and marcaſitical Bodies, and ſometimes Lead.

It is found in *Hungary*, *Bohemia*, *Saxony*, *Spain*, *France*, *Italy*, and the *Eaſt-Indies*; but no where in greater plenty than about *Roſenburg* in *Hungary*; where it is found chiefly in a whitiſh ſparry Stone on the ſides of the Hills; and is gathered by the poor People, after it has been cleared and uncovered by Rains. The purer native Cinnabar has been uſed to be much eſteemed both by the Painters and in Medicine; but our factitious kind equalling it in Beauty, and being much cheaper, has baniſhed it from among the Painters. And it were to be wiſh'd the Caſe were the ſame in Medicine, for the Doſe may be much better aſcertained in the factitious, than the native; which we can never be ſure of as to its exact degree of Purity, and which may alſo contain other mineral Subſtances, which we have no Intent of giving, mixed and incorporated with it. That of *Hungary*, however, is what always ought to be kept for internal Uſe (if it be to be ſo uſed) as it is commonly more pure than that of any other Place.

τέχνης. οἱ μὲν γὰρ ἐκ τοῦ ἴσου πολὺ περιποιοῦσιν· οἱ δὲ, ὀλίγον, ἢ οὐθέν· ἀλλὰ πλύσμασι ἐπάνω χρῶνται, ἓν πρὸς ἓν ἀλείφοντες. γίνεται δὲ τὸ μὲν ὑφιστάμενον κάτω Κιννάβαρι· τὸ δ' ἐπάνω καὶ πλεῖον, πλύσμα.

ρδ'. Καταδεῖξαι δέ φασι καὶ εὑρεῖν τὴν ἐργασίαν, Καλλίαν τινα Ἀθηναῖον ἐκ τῶν ἀργυρείων. ὃς οἰόμενος ἔχειν τὴν ἄμμον χρυσίον, διὰ τὸ λαμπυρίζειν, ἐπραγματεύετο καὶ συνέλεγεν. ἐπεὶ δὲ ᾔσθετο ὅτι οὐκ ἔχει, τὸ δὲ τῆς ἄμμου κάλλος ἐθαύμαζε διὰ τὴν χρόαν, οὕτως ἐπὶ τὴν ἐργασίαν ἦλθε ταύτην. οὐ παλαιὸν δ' ἐστίν· ἀλλὰ περὶ ἔτη μάλιστ' ἐνενήκοντα εἰς ἄρχοντα Πραξίβουλον Ἀθήνησι.

ρε'. Φανερὸν δ' ἐκ τούτων, ὅτι μιμεῖται τὴν φύσιν ἡ τέχνη, τὰ δὲ ἴδια ποιεῖ. καὶ τούτων τὰ μὲν χρήσεως χάριν, τὰ δὲ μόνον φαντασίας, ὥσπερ τὰς ἀλιπεῖς. ἔνια δ' ἴσως ἀμφοῖν. ὥσπερ χυτὸν ἄργυρον [p]. ἔστι γάρ τις χρεία καὶ τούτου. ποιεῖται δ' ὅταν τι (Κιννάβαρι)

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[p] We have now many ways of extracting the Quickſilver from Cinnabar, but all by the Aſſiſtance of Fire. Where the Mineral is rich, the common way is by a kind of Deſtillation *per deſcenſum* in this Manner: After beating it to Powder, it is put into narrow-neck'd earthen Veſſels, which are ſtopped with bundles of Moſs crambed pretty hard into them: Theſe are then turned bottom upwards, and their Necks, thus ſtopped, let into the Mouths of other

Powder, and others very little, or none at all. The washing they use is very light and superficial, and they wet it every time separately and carefully. That which at last subsides is the Cinnabar, and that which swims above in much larger quantity is only the superfluous Matter of the Washing.

CIV. It is said, that one *Callias*, an *Athenian*, who belonged to the Silver Mines, invented and taught the making this artificial Cinnabar. He had carefully got together a great quantity of this Sand, imagining, from its shining Appearance, that it contained Gold: But when he had found that it did not, and had had an Opportunity, in his Tryals of admiring the Beauty of its Colour, he invented and brought into use this Preparation of it. And this is no old thing, the Invention being only of about ninety Years date; *Praxibulus* being at this Time in the Government at *Athens*.

CV. From these Accounts it is manifest, that Art imitates Nature, and sometimes produces very peculiar Things; some of which are for Use, others for Amusement only, as those employed in the ornamenting Edifices; and others, both for Amusement and Use. Such is the Production of Quicksilver [p], which has its Uses: This is obtained from

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Vessels of a like Shape, which are buried in the Ground. After the Joinings are very firmly luted, a Fire is made about the Place; and when the Vessels grow hot, the Quicksilver gets loose, and draining through the Moss which stops the Mouth of the upper Vessel, in which it is, falls perfectly fine and pure into the lower. This is a common way at the richer Mines. At others, the Cinnabar is put into Retorts, and set in proper Furnaces; and

τριφθῇ μετ' ὄξους ἐν ἀγγείῳ χαλκῷ, καὶ δοίδυκι χαλκῷ. Τὰ μὲν οὖν τοιαῦτα τάχ' ἄν τις λάβοι πλείω.

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and the Quickſilver is raiſed by the Heat in Fumes and falls into the Receiver, which is filled three parts with cold Water, to make it condenſe again the more readily. But there is ſome Cinnabar which contains ſo much Sulphur, that the Quickſilver it holds can never be got looſe, without the Addition of ſomething to abſorb the Sulphur. This Kind is generally deſtilled by the Retort, with Quicklime, Filings of Iron, Wood-aſhes, Salt of Tartar, Potaſhes, or ſomething of that kind. And from the Reſiduum of theſe Deſtillations, a pure and genuine *Lac Sulphuris* may be prepared, by the common way of boiling and precipitating with deſtilled Vinegar. Our factitious Cinnabar, made only by ſubliming Mercury and Sulphur together, exactly reſembles the native of ſome kinds in all its Qualities; and yields its Quickſilver pure and fluid again by the ſame Means.

But beſide all theſe ways of procuring Quickſilver from the Cinnabars, it is ſometimes found pure, unmixed, and fluid in the Bowels of the Earth. And this Kind *Dioſcorides* diſtinguiſhes by the Name of ὑδράργυρος καθ' ἑαυτόν. This is cleared from its Earth by waſhing in common Water; and from ſome other heterogene Matters, by Salt and Vinegar, and then is ſtrained through Leather, and called Virgin Quickſilver.

native Cinnabar, rubbed with Vinegar in a braſs Mortar with a braſs Peſtle. And many other Things of this kind others, perhaps, may hit upon.

It is a Mineral of a perfectly ſingular kind, and when pure and unmixed, keeps conſtantly its fluid Form. It may be amalgamed with all other metalick Subſtances, but is moſt difficultly made to mix with Antimony, Iron, and Copper. It penetrates the Subſtance of all Metals, and diſſolves, and makes them brittle. It is the heavieſt of the Metals except Gold, which is to it as 4 to 3, or thereabout; and therefore will not ſwim in it, as all other Metals do. It is, however, notwithſtanding its Weight, extremely volatile, and eaſily raiſed in form of a very ſubtle Vapour; and in that Form, diſſipated entirely by means of Fire.

Quickſilver, from its ill Effects on the Miners and People employed about large Quantities of it, was long eſteemed a Poiſon among the Antients. *Dioſcorides* reckons it a thing which muſt have very pernicious Effects in Medicine; and *Galen* believed it highly corroſive. It firſt got into Uſe externally among the *Arabians*; and afterwards, but not till long afterwards, got introduced into the Number of internal Medicines, from the repeated Obſervations of its Safety and good Effects when given to Cattle, and from the hardy Attempts of ſome unhappy People, who had ventured to take it down in large Quantities (in order to procure Abortion) without any ill Effect.

PEDANIOS DIOSCORIDES

On the Nature of Cinnabar and Quicksilver

A.D. FIRST CENTURY

Englished by JOHN GOODYER, A.D. 1655

During the first century A.D. a Greek physician who served in Nero's army, Pedanios Dioscorides of Anazarba, prepared a compendium of medical and botanical information which for more than a millenium served as a source-book for herbalists. The sections on cinnabar and quicksilver shown herein are from the first English translation, prepared by John Goodyer between 1652 and 1655. This manuscript is now in the collection of the Bodleian Library, Oxford University, and is reproduced by courtesy of the Library. Goodyer's translation was not published until 1933, when it appeared as *The Greek Herbal of Dioscorides Illustrated by a Byzantine A.D. 512 Englished by John Goodyer A.D. 1655. Edited and First Printed A.D. 1933 by Robert T. Gunther, M.A., Hon. LL.D. With Three hundred and ninety-six Illustrations. Oxford University Press.*

Kinnabari. Cinnabari. Cap. 109.

Some do think Cinnabaris to be the same with that which is called Ammium, being deceived herein. For the Ammium is made in Spain of a certain stone mixed with the Arguritidical sand, for otherwise it is not known; but in the furnace it changes into a very lively and flaming color, but it has among metals a choking smell, and therefore the workmen there put bladders about their faces, that they may see, but not draw in the vapor. But the Painters use this for the sumptuous adornings of walls. But the Cinnabaris which we speak of, is brought from Africa, and is sold for much, and is so scarce that there is hardly enough for the painters for the variety in the lines, and it is also of an heavy, or deep color, whence some thought it to be the blood of the dragon. But Cinnabaris has the same virtue that Haematitis has, being good for eye-medicines, and that most effectually, for it is more binding and blood-staunching, and being taken with Cerat, it heals burnings, and the breaking out of pustules.

Udraguros. Hydrargyrum. Cap. 110.

But Hydrargyrum is made of that which is called Ammion, this also being abusively called Cinnabaris, putting an iron spoon having Cinnabaris in an earthen pot, they cover the Cup daubing it about with clay, then they make a fire under with coals; for the soot that sticks to the pot being scraped off, and cooled, becomes Hydrargyrum. It is found also in the place where silver is melted standing together by drops on the roofs. And some say that Hydrargyrum is found by itself in the mines. But it is kept in glass or lead or tin or silver vessels, for it eats through all other matter, and makes it run out. But it has a pernicious faculty being drank, eating through the inward parts, by its weight. But this is helped by much milk being drank, or wine with wormwood, or the decoction of smallach, or with the seed of Horminum, or with Origanum, or with Hyssop with wine. But the dust of gold, that is, the smallest scraping, is a miraculous help for this Hydrargyrum.

1 ## Ὤχρα. Ochra. Cap. 108.

2 Ὤχραν δὲ ληπτέον τὴν κουφοτάτην, καὶ διόλου
That oaker is to be chosen wch is lightest, & wholly
3 μηλίνην, κατακορῆ δέ, καὶ ἄλιθον, καὶ εὔθρυπτον.
yellowish, of a full colour, & unstonie, & brittle,
4 Ἀττικὴν δὲ τῷ γένει, καύσεις δέ, ~~καὶ~~
& of yt of Athens by kinde, but wee must burne,
5 καὶ πλυνεῖς ταύτην ὡς τὴν καδμείαν. Ἔχει δὲ
and wash this as the Cadmia. But it hath
6 δύναμιν .1. σηπτικήν, διαφορητικὴν φλεγμονῶν
a facultie of putrifying, of dissolving inflamations,
7 καὶ φυμάτων, καταστέλλει τε τὰ ὑπερσαρκοῦντα
& little swellings, & it doth represse excrescencies of flesh
8 καὶ πληροῖ τὰ κοῖλα .2. σὺν κηρωτῇ, καὶ θρύπτει πώρους.
& fills up ye hollow, wth Cerat; & diminisheth callosities.

9 ## Κιννάβαρι. Cinnabari. Cap. 109.

10 Τινὲς οἴονται Κιννάβαρι ~~ὑπάρχειν~~ ὑπάρχειν ταὐτὸν
Some doe thinke Cinnabaris to be ye same
11 τῷ καλουμένῳ .1. Ἀμμίῳ, πλανώμενοι. Τὸ μὲν γὰρ
wth yt wch is called Amium ~~Atinium~~, being deceived herein. For ye

1 Ἄμμιον σκευάζεται ἐν Ἰσπανίᾳ ἐκ τινὸς
Aminium is made in Spaine of a certaine
2 λίθου μεμιγμένου τῇ ἀργυρίτιδι ψάμμῳ. 2.
stone mixed wth ye Argyritidicall sand.
3 ἄλλως δὲ οὐ γινώσκεται, ἐν δὲ τῇ χώνῃ μεταβάλλει
for otherwise it is not knowne, but in ye furnace it changeth
4 εἰς εὐανθέστατον, καὶ φλογωδέστατον χρῶμα,
into a ~~very~~ lively and flaming colour,
5 ἔχει δὲ ἐν τοῖς μετάλλοις πνιγώδη ἀποφοράν
but it hath amongst mettalls a choaking smell,
6 οἱ γοῦν ἐπιχώριοι περιτίθενται φύσας
And therefore ye workemen there, putt bladders
7 προσώποις, πρὸς τὸ βλέπειν μέν, μὴ σπᾶν δὲ
about their faces, yt they may see, but not draw in
8 τὸν ἀέρα. οἱ δὲ ζωγράφοι χρῶνται αὐτῷ
the vapour. But the painters use this
9 εἰς τὰς πολυτελεῖς ἐγκοσμήσεις τῶν τοίχων.
for the sumptuous adornings of walls.
10 τὸ δὲ οὕτω κιννάβαρι κομίζεται μὲν ἀπὸ
But ye Cinnabaris wch wee spake off, is brought from
11 Λιβύης, πιπράσκεται δὲ πολλοῦ, καὶ τοσοῦτόν ἐστι
Africa, and is sold for much, & is soe scarce
12 ὡς μόλις ἐξαρκεῖν τοῖς ζωγράφοις εἰς τὴν
yt there is hardly enough for ye painters for the

1 εἰς τὴν ποικιλίαν ἐν ταῖς γραμμαῖς· ἔστι δὲ καὶ
for ye varietie in the lines, & it is also
2 βαρύχρουν, ἢ βαθύχρουν, ὅθεν τινὲς ἐνόμισαν
of an heavy, or deep colo[r], whence some thought
3 αὐτὸ εἶναι αἷμα δράκοντος. Τὸ δὲ κιννάβαρι
it to be ye bloud of ye dragō. But Cinnabaris
4 ἔχει τὴν αὐτὴν δύναμιν τῷ αἱματίτῃ, ἁρμόδιον
hath the same virtue yt Haematitis hath, being good
5 εἰς ὀφθαλμικά, πλὴν ἐπιτεταμένως, ἔστι γὰρ
for eye-medicines, & yt more effectually, for it is
6 μᾶλλον στύφον, καὶ ἴσχαιμον, καὶ ἀναληφθὲν
more binding, & bloud-stanching, & being taken
7 κηρωτῇ ~~θεραπεύει~~ θεραπεύει πυρίκαυστα, καὶ
wth Cerat it heals burnings, and
8 ἐξανθήματα
ye breaking out of pustles.

9 Ὑδράργυρος. Hydrargyrū. Cap. 110.

10 Ὑδράργυρος δὲ σκευάζεται ἀπὸ τοῦ λεγομένου
But Hydrargyrū is made of yt wch is called
11 Ἄμμιου, τούτου δὲ καὶ καταχρηστικῶς λεγομένου
minium
Amion, this also being abusively called

imposita ferrea concha continente

1 κινναβάρεως, θέντες σιδηροῦν κόγχον ἔχοντα

Cinnabaris, putting an iron spoone having

cinnabarim fictilis patinae adaptant

2 κιννάβαρι ἐπὶ κεραμέας λοπάδος, περικαθαπτοῦσιν

Cinabaris in an earthen pott, they cover

chijmam superillinunt luto deindeque succendunt

3 ἄμβικα περιαλείψαντες πηλῷ, εἶτα ὑποκαίουσιν

the Cupp dawbing it about wth clay, then they make a fire und^r

carbonibus nam fuligo quae adhaerescit calyci ἀμβίκι

4 ἄνθραξιν· ἡ γὰρ αἰθάλη προσιζοῦσα τῷ ἀμβίκῳ

wth coales for ye soote yt sticks to ye pott

τ' ἀπεξυσμένη

derasa refrigerataque coit in Argentum vivum

5 ἀποξεσθεῖσα, καὶ ἀποψυχθεῖσα, γίνεται ὑδράργυρος.

being scraped off, & cooled, becomes Hydrargyru.

τὸν ἄργυρον

6 Εὑρίσκεται δὲ καὶ ἐν τῷ μεταλλεύεσθαι

It is found also in ye place where silver is molted

7 συνεστῶσα κατὰ σταλαγμοὺς ἐν ταῖς στέγαις.

standing togeth^r by drops on ye roofs.

8 Ἔνιοι δὲ ἱστοροῦσι καὶ τὴν ὑδράργυρον εὑρίσκεσθαι

And some say that Hydrargyru is found

9 καθ' ἑαυτὴν ἐν τοῖς μετάλλοις· φυλάττεται δὲ

by itself in ye mines. But it is kept

10 ἐν ὑαλίνοις, ἢ μολιβδίνοις, ἢ κασσιτερίνοις, ἢ

in glassen, or leaden, or tinnen, or

11 ἀργυροῖς ἀγγείοις, διεσθίει γὰρ πᾶσαν ἄλλην ὕλην

silver vessells, for it eats through all other matter,

12 καὶ ποιεῖ ἀπορρεῖν. Ἔχει δὲ φθαρτικὴν δύναμιν

& makes it run out. But it hath a pnitious facultie

1 ποθεῖσα διαβιβρώσκουσα τὰ ἐντὸς τῷ βάρει
being dranck, eating thorough ye inward parts, by its weight.
2 Βοηθεῖται δὲ πολλῷ γάλακτι πινομένῳ, ἢ ~~καὶ~~
But this is helpt by much milke being dranck, or ~~and~~
3 οἴνῳ σὺν ἀψινθίῳ, ἢ ἀφεψήματι σελίνου, ἢ
wine with wormwood, or ye decoction of smallach, or
4 σπέρματι ὁρμίνου, ἢ ὀριγάνῳ, ἢ ὑσσώπῳ σὺν
with ye seed of Hormimum, or with Origanum, or with Hyssop with
5 οἴνῳ. 2. [ῥίνημα δὲ χρυσοῦ, τουτέστι, λεπτότατον
wine. [But ye dust of gold, yt is, ye smallest
6 ξῦσμα ἐστὶ θαυμαστὸν βοήθημα ὑδραργύρου]
scraping, is a miraculous help for this Hydrargyrum]

7 Μίλτος Σινωπικὴ. Rubrica Sinopica. Cap. 111.

8 Μίλτος Σινωπικὴ. κρατίστη ἡ πυκνή, καὶ βαρεῖα,
Rubrica Sinopica ye best is yt which is thick, and heavie,
9 ἡπατίζουσα, ἄλιθος, ὁμόχρους, πολύχυτος ἐν τῇ
of a liver colour, without stones, but of one colour, much spreading abroade in ye
10 ἀνέσει. συλλέγεται δὲ ἐν Καππαδοκίᾳ, ἐν τισὶ
dissolving. It is gathered in Cappadocia in certaine
11 σπηλαίοις. διυλίζεται δὲ καὶ φέρεται εἰς Σινώπην
dens. but it is purified, and caryed to ye citie Sinope

CAIUS PLINIUS SECUNDUS

On Minium and the Humour That Is Known as Quicksilver

A.D. ABOUT 77

Englished by JOHN BOSTOCK and H. T. RILEY, A.D. 1855

Most of the writings of Pliny, Roman savant (born 23? A.D., died 79 A.D.), have been lost; his 37-book *Historiae Naturalis,* however, has been published in Latin and translated into other languages many times since 77 A.D., when the first ten books were released. The extracts quoted herein are from Book 33 of *The Natural History of Pliny. Translated, With Copious Notes and Illustrations by the Late John Bostock . . . . . and H. T. Riley. . . . . London: Henry G. Bohn, York Street, Covent Garden. MDCCCLV.*, in the collection of the California State Division of Mines Library, San Francisco, California.

The first printed English translation of Pliny is *The Historie of the World*, by Philemon Holland, published in London in 1601. Reproduction of the title page of *The second Tome* shown on the following page is from a copy in The Huntington Library, San Marino, California.

THE HISTORIE OF THE WORLD.

Commonly called,

THE NATVRALL HISTORIE OF C. PLINIVS SECVNDVS.

Translated into English by PHILEMON HOLLAND *Doctor of Physicke.*

The second Tome.

LONDON,
Printed by Adam Islip.
1601.

There is a mineral also found in these veins of silver, which yields a humour that is always liquid, and is known as "quicksilver." It acts as a poison [dissolvent] upon everything, and pierces vessels even, making its way through them by the agency of its malignant properties. All substances float upon the surface of quicksilver, with the exception of gold, this being the only substance that it attracts to itself. Hence it is, that it is such an excellent refiner of gold; for, on being briskly shaken in an earthen vessel with gold, it rejects all the impurities that are mixed with it. When once it has thus expelled these superfluities, there is nothing to do but to separate it from the gold; to effect which, it is poured out upon skins that have been well tawed, and so, exuding through them like a sort of perspiration, it leaves the gold in a state of purity behind. . . . .

It is also in silver-mines that minium [cinnabar] is found, a pigment held at the present day in very high estimation; and by the Romans in former times not only held in the highest estimation, but used for sacred purposes as well. . . . .

The Greeks . . . . . give to minium the name of "cinnabaris," and hence the error caused by the two meanings of the same word; this being properly the name given to the thick matter which issues from the dragon when crushed beneath the weight of the dying elephant, mixed with the blood of either animal. . . . . This cinnabaris, too, is extremely useful as an ingredient in antidotes and various medicaments. But, by Hercules! our physicians, because minium also has the name of "cinnabaris," use it as a substitute for the other, and so employ a poison, as we shall shortly show it to be. . . . .

According to Juba minium [cinnabar] is also a production of Carmania, and Timagenes says that it is found in Æthiopia. But from neither of those regions is it imported to Rome, nor, indeed, from hardly any other quarter but Spain; that of most note coming from Sisapo [Almaden], a territory of Baetica, the mine of minium there forming a part of the revenues of the Roman people. Indeed there is nothing guarded with a more constant circumspection; for it is not allowable to reduce and refine the ore upon the spot, it being brought to Rome in a crude state and under seal, to the amount of about two thousand pounds per annum. At Rome, the process of washing is performed, and, in the sale of it, the price is regulated by statute; it not being allowed to exceed seventy sesterces per pound. There are numerous ways, however, of adulterating it, a source of considerable plunder to the company.

For there is, in fact, another kind of minium [lead oxide], found in most silver-mines as well as lead-mines, and prepared by the calcination of certain stones that are found mixed with the metallic vein—not the minerals, however, to the fluid humours of which we have given the name of quicksilver; for if those are subjected to the action of fire they will yield silver—but another kind of stone that is found with them. . . . .

Genuine minium ought to have the brilliant colour of the kermes berry; but when that of inferior quality is used for walls, the brightness of it is sure to be tarnished by the moisture, and this too, although the substance itself is a sort of metallic mildew. In the mines of Sisapo, the veins are composed exclusively of the sandy particles of minium, without the intermixture of any silver

whatever; the practice being to melt it like gold. Minium is assayed by the agency of gold in a state of incandescence: if it has been adulterated, it will turn black, but if genuine, it retains its colour. . . . .

. . . . . Persons employed in the manufactories in preparing minium protect the face with masks of loose bladder-skin, in order to avoid inhaling the dust, which is highly pernicious; the covering being at the same time sufficiently transparent to admit of being seen through. . . . .

Human industry has also discovered a method of extracting hydrargyros from the inferior minium, a substitute for quicksilver. . . . . There are two methods of preparing this substance; either by pounding minium and vinegar with a brazen pestle and mortar, or else by putting minium into flat earthen pans, covered with a lid, and then enclosed in an iron seething-pot well luted with potter's clay. A fire is then lighted under the pans, and the flame kept continually burning by the aid of the bellows; which done, the steam is carefully removed, that is found adhering to the lid, being like silver in colour, and similar to water in its fluidity. This liquid, too, is easily made to separate in globules, which, from their fluid nature, readily unite.

☿ ὑδραργυρος

CHAPTER II

IN WHICH ARE SET FORTH DISCOURSES UPON THE STONE OF PHILOSOPHERS: THE PART ARGENTVIVE

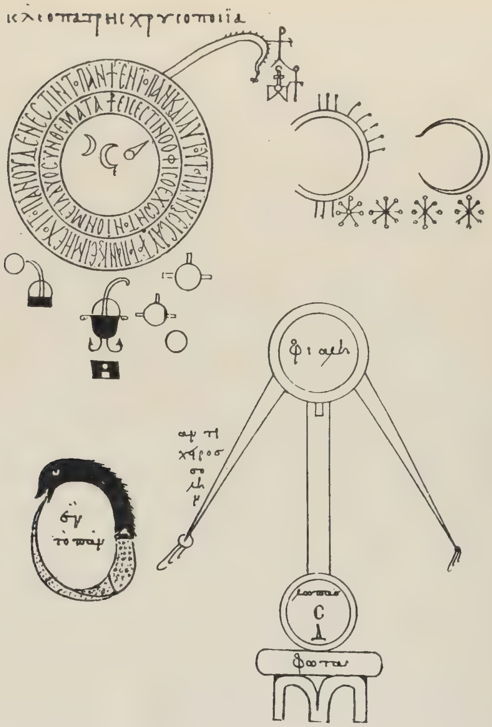
BY

ALCHEMISTES OF ARABY

Between the sixth century . . . and the seventh century of our era, mercury took the sign of the planet Hermes . . . previously assigned to tin.

The sign of cinnabar is a circle with a dot in the center. The same sign was later, at the close of the middle ages, employed to represent the philosophers' egg, the sun, and gold . . . but is generally assigned to cinnabar, a fundamental ingredient of the philosophers' egg. M. Berthelot, 1889.

⊙ κιννάβαρις



THE GOLD-MAKING ART OF CLEOPATRA. Third century (?) A.D., from a manuscript in the collection of St. Mark's in Venice.

Beneath the title is a design formed by three concentric circles; in the center are the signs for gold, silver (moon with appendage), and mercury (small moon); in the interior ring is the Greek inscription "The serpent becomes one, the one with venom, after the two signs;" in the exterior ring is the Greek inscription "This one is in himself complete; and if he is not in himself complete, he is not this one." The "tail" extending from the top right portion of the outer circle indicates that the system is that of the mystic serpent *Ouroboros;* significance of the design at the end of the tail is not known. The figures to the right of the design may be chemical symbols for the transmutation of lead to silver.

The small central figure under the concentric circles represents apparatus for fixing metals; it is set over a hotwater bath, provided with two curved feet, and stands over a furnace; the tube is for the release of gas and vapor. The little figure to the left represents a similar piece of apparatus with a balloon top to receive the vapors from the tube.

The two small circles to the right, with the three rectilinear appendages, apparently represent apparatus on tripods, set over the fire. The lower circle with the center point symbolizes the philosophers' egg, or cinnabar.

Below at the left is the serpent *Ouroboros* and the words "This one is in himself complete." To the right of the serpent is a large distiller set over a furnace. The lower receptacle is the matrass, the upper receptacle is the alembic. Vapor rises from the matrass through the large tube into the narrow opening of the alembic; in the alembic it condenses, and falls out drop by drop from the inclined condensing tubes. From *Chimie des anciens,* by M. Berthelot, 1889.

ABU MUSA JÂBIR IBN HAYYÂN [GEBER]

On the Thing Which Perfects in Minerals

EIGHTH CENTURY

Englished by RICHARD RUSSELL, 1678

Numerous fragmental writings on alchemy have been attributed to a Muslim chemist Abu Musa Jâbir Ibn Hayyân [Geber, 721-813 A.D.], but no original Arabic text has been found. The extracts quoted herein are from an English translation made from a medieval Latin work and published as *The Works of Geber, The Most Famous Arabian Prince and Philosopher, Faithfully Englished by R. R. a Lover of Chymistry. . . . . London, Printed from N.E. for Thomas James Mathematical Printer to the Kings most Excellent Majesty, at the Sign of the Printing-press in Mincing Lane; and are to be sold by Booksellers. MDCLXXVIII.*

Of Things Perfecting and Corrupting Metallick Bodies

. . . . . The *Thing* which perfects in *Minerals*, is the substance of *Argentvive* and *Sulphur* proportionately commixt, by long and temperate decoction in the Bowels of clean, inspissate, and fixed *Earth* (with conservation of its *Radical Humidity* not corrupting) and brought to a solid fusible Substance, with due Ignition, and rendred Malleable. By the *Definition* of this *Nature* perfecting, we may more easily come to the Knowledge of the *Thing* corrupting. And this is that which is to be understood in a contrary Sense, *viz.* the pure *substance* of *Sulphur* and *Argentvive*, without due Proportion commixed, or not sufficiently decocted in the Bowels of unclean, not rightly inspissate nor fixed *Earth*, having a Combustible and Corrupting *Humidity*, and being of a rare and porous Substance; or having Fusion without due Ignition, or no Fusion, and not sufficiently Malleable. . . . .

Of the Stone of Philosophers, That It Is One Only, for the White, and for the Red, and from what Things It Is Extracted. And of the Possibility and Way of Perfection.

We find Modern Artists to describe to us one only *Stone*, both for the *White* and for the *Red*; which we grant to be true: for in every *Elixir*, that is prepared, *White* or *Red*, there is no other Thing than *Argentvive* and *Sulphur*, of which, one cannot act, not be, without the other: Therefore it is called, by *Philosophers*, one *Stone*, although it is extracted from many Bodies or Things. For it would be a foolish and vain thing to think to extract the same from a Thing, in which it is not, as some infatuated Men have conceited; for it never was the intention of *Philosophers*: yet they speak many things by similitude. And because all *Metallick* Bodies are compounded of *Argentvive* and *Sulphur*, pure or impure, by accident, and not innate in their first Nature; therefore, by convenient *Preparation*, 'tis possible to take away such Impurity. For the *Expoliation* of *Accidents* is not impossible: therefore, the end of *Preparation* is, to take away *Superfluity*, and supply the *Deficiency* in Perfect Bodies. But *Preparation* is diversified according to the *Diversity* of things indigent. For experience hath taught us diverse ways of acting, *viz. Calcination*, *Sublimation*, *Descension*, *Solution*, *Distillation*, *Coagulation*, *Fixation* and *Inceration*: All which we sufficiently declare in the *Sum of the Perfection of the Magistery*. For these are Works helpful in *Preparation*.

Of Argentvive, or Mercury

ARgentvive, which also is called *Mercury* by the *Ancients*, is a viscous *Water* in the *Bowels* of the *Earth*, by most temperate *Heat* united, in a total *Union* through its least parts, with the substance of white subtile *Earth*, until the *Humid* be contempered by the *Dry*, and the *Dry* by the *Humid*, equally. Therefore it easily runs upon a plain *Superficies*, by reason of its *Watery Humidity*; but it adheres not although it hath a viscous *Humidity*, by reason of the *Dryness* of that which contemperates it, and permits it not to adhere. It is also (as some say) the *Matter* of *Metals* with *Sulphur*. And it easily adheres to three *Minerals*, *viz.* to *Saturn* [lead], and *Jupiter* [tin], and *Sol* [gold], but to *Luna* [silver] more difficultly. To *Venus* [copper] more difficultly than to *Luna*; but to *Mars* [iron] in no wise, unless by *Artifice*. Therefore hence you may collect a very

great *Secret*. For it is amicable, and pleasing to *Metals*, and the *Medium* of conjoyning *Tinctures*; and nothing is submerged in *Argentvive*, unless it be *Sol*. Yet *Jupiter* and *Saturn*, *Luna* and *Venus*, are dissolved by it, and mixed; and without it, none of the *Metals* can be gilded. It is fixed, and it is a *Tincture* of *Redness* of most exuberant *Refection*, and fulgid *Splendor*; and then it recedes not from *Commixtion*, until it is in its own *Nature*. Yet it is not our *Medicine* in its *Nature*; but it can sometimes likewise help in the *Case*.

Of the Nature of Mercury, or Argentvive

IN *Argentvive* . . . . ., there is a necessity of removing *Superfluities*, For it hath *Causes* of *Corruption, viz*. An *Earthy Substance*, and *Adustible Wateriness* without *Inflamation*. Yet some have thought it not to have any superfluous *Earth*, and *Uncleanness*; but what is thought by them is vain. For We see it to consist of much *Lividness*, and not of *Whiteness*. And We likewise see the *Black* and *Feculent Earth* to be separated from it with easie *Artifice*, by a *Lavation*, the *Method* of which We will shew. But because We are by that to acquire a twofold *Perfection, viz*. To make a *Medicine*, and to perfect it; therefore We must necessarily prepare the same by the *Degree* of a twofold *Mundation*; for two *Cleansings* of *Mercury* are necessary. One, by *Sublimation* for the *Medicine*, and this is here shewed; and the other, by a *Lavament* for *Coagulation*; and that also shall be shewed. For, if We should create *Medicine* of it, then there is a necessity to cleanse it from the *Feculency* of its *Earthiness* by *Sublimation*; least it create a *Livid Colour* in *Projection*: and also to remove its *Fugitive Wateriness*, least it make the whole *Medicine Fugitive* in *Projection*; and to keep safe the middle *Substance* thereof, for *Medicine*: Of which the property is not to be burned, and to defend from *Combustion*, and not to flie it self; and also to make fixed. Therefore We prove that to be a *Perfective*, by many *Experiences*. For We see *Argentvive* more nearly to adhere to *Argentvive*, and to be more beloved by the same; but next to it is *Gold*, and after that *Silver*.

Wherefore, hence it follows, that *Argentvive* is more friendly to its own *Nature*: but We see other *Bodies* not to have so great *Conformity* to it, and therefore We in very deed find them less to partake of the *Nature* thereof. And whatsoever *Bodies* We see more to defend from *Adustion*, those We consider to possess more the *Nature* of it. Therefore 'tis manifest, that *Argentvive* is the *Perfective* and *Salvative* of *Adustion*, which is the *Ultimate* of *Perfection*.

But the Second *Degree* of *Mundation*, is for its *Coagulation*. And the washing away of its *Earthiness* for one *Day* only, is sufficient for it. The *Method* of which *Washing* is this: Take an *Earthen Dish*, and into it put your *Argentvive*, upon which pour only so much of most strong *Vinegar*, or any other like *Thing*, as will be sufficient to cover it. Then set the *Dish* over a gentle *Fire*, that the whole may be warm and not too hot; and stir it continually with your *Fingers* on the *Bottom* of the *Dish*, that the *Argentvive* may be divided in the likeness of a subtile white *Powder*, until the whole *Vinegar* be evaporated, and the *Mercury* revived. After you see the *Vinegar* to come off feculent and black, cast that away, and wash the *Mercury* with fresh *Vinegar*; repeating this *Washing*, until you see the *Colour* of its *Earthiness* to be perfectly changed into a clear *Colour*, mixt with a white and coelestine *Colour*, which is a sign of perfect *Washing*. Therefore when it comes to that, project upon it the *Medicine* of

Coagulation, and it will be *Coagulated* into a *Solifick*, or *Lunifick*, according as the *Medicine* was prepared; . . . . . From what is now mentioned, 'tis manifest, that *Argentvive* is not *Perfective* in its *Nature*; but that is, which is produced of it by Our Artifice. . . . .

Of the Nature of Sol, or Gold

. . . . . *Sol* is created of the most subtile *Substance* of *Argentvive*, and of most clear *Fixture*; and of a small *Substance* of *Sulphur* clean, and of pure *Redness*, fixed, clear, and changed from its own *Nature*, tinging that. And because there happens a *Diversity* in the *Colours* of that *Sulphur*, the *Citrinity* (or *Yellowness*) of *Gold* must needs have a like *Diversity* . . . . . the most subtile *Substance* of *Argentvive* brought to *Fixation*, and the purity of the same, and the most subtile *Matter* of *Sulphur*, fixed and not burning, is the whole *Essential Matter* of *Gold*. But in it is found a greater *Quantity* of *Argentvive*, than of *Sulphur*; wherefore *Argentvive* hath greater *Ingress* into it. . . . .

Of the Easie Susception of Argentvive

. . . . . *Bodies* containing the greatest *Quantity* of *Argentvive*, are *Bodies* of *Perfection*. Wherefore, it is to be supposed, that those *Bodies* are more nigh to *Perfection*, which more amicably imbibe *Argentvive*. The sign of this is, the easie *Susception* of *Argentvive* by a *Solar* or *Lunar Body* of *Perfection*. For this same *Reason*, if a *Body* altered do not easily receive *Argentvive* into its *Substance*, it must needs be very remote from the Compleatment of *Perfection*.

ALÎ IBN SÎNÂ (AVICENNA)

On the Nature of Mercury

1022

Englished by E. J. HOLMYARD and D. C. MANDEVILLE, 1927

The extracts from the works of Avicenna quoted herein are from *Avicennae de congelatione et conglutinatione lapidum, being sections of the Kitâb al-Shifâ', by E. J. Holmyard and D. C. Mandeville. Libraire Orientaliste, Paul Guethner: 13 rue Jacob, Paris. 1927,* in the collection of the Library of the University of California at Berkeley. This part (*de congelatione et conglutinatione lapidum*) of the *Kitâb al-Shifâ'* (*Book of Remedy*) has often been attributed to Aristotle, because in medieval Latin manuscripts it has been found appended as three paragraphs (*de Mineralibus*) to his fourth book of *Meteorologica.* The authorship is no longer in doubt, however, for three manuscript Arabic texts are now known. Avicenna, the writer, was an Arab physician born at Afsenna near Bokhara in 980 A.D. His system of medicine was compiled principally from the Greek writers.

The fragment of Arabic text reproduced herein is photographed from Arabic manuscript OR. 2873 in the Department of Oriental Printed Books and Manuscripts of the British Museum, by courtesy of the Museum.

مسام الارض للعيون واشعار قلوب ضيقة العامة رعب الله تعالى فصل في تكون المعدنيات وقد حان لنا ان نتكلم في احوال الجواهر المعدنية
فنقول ان الاجسام المعدنية تكاد ان تكون اقسامها اربعة الاحجار والذائبات والكباريت والاملاح وذلك ان من الاجسام المعدنية ما هو ضعيف
الجوهر ضعيف التركيب والمزاج ومنه ما هو قوي الجوهر فمنه ما يتطرق ومنه ما لا يتطرق وما هو ضعيف الجوهر فمنه ما هو ملحي يحله الرطوبة بسهولة مثل الشب
والزاج والنوشادر والقلقند ومنه ما هو دهني لا يحل بالرطوبة وحدها بسهولة مثل الكبريت والزرنيخ واما الزيبق فهو من جملة القسم الثاني على انه عنصر المتطرقات
او شبيه بعنصر المتطرقات وجميع المتطرقات ذائبة ولو بالحيلة واكثر ما لا يتطرق فلا يذوب الا بالحيلة ولنا ان نقول عنصر ومادة المتطرقات جوهر مائي يخالط
جوهرا ارضيا مخالطة شديدة لا يبرا منه وجمد الجوهر المائي بالبرد بعد فعل الحر فيه الانضاج ويكون في جملته ما هو حي لم يجمد لدهنيته ولذلك يتطرق
واما المجرميات من الجواهر المعدنية الحجرية فمادتها ايضا مائية ولكن ليس جمودها بالبرد وحده بل جمودها باليبس المحيل للمائية الى الارضية وليس فيها رطوبة دهنية
فلذلك لا تتطرق ولاجل ان اكثر انعقادها باليبس فلذلك لا يذوب اكثرها الا ان يحتال عليها بالحيل الطبيعية المذيبة واما الشب والنوشادر فمن جنس
الاملاح الا ان نارية النوشادر اكثر من ارضيته فلذلك يتصعد بكليته فهو ماء خالطه دخان حار لطيف جدا كثير النارية وانعقد باليبس واما
الكباريت فانها قد عرض لمائيتها ان تخمرت بالارضية والهوائية تخمرا شديدا بالتخمير الحراري حتى صارت دهنية ثم انعقدت بالبرد واما الزاجات فانها
مركبة من ملحية وكبريتية وحجارة وفيها قوة بعض الاجساد الذائبة فما كان مثل القلقند والقلقطار فتكونها من جلالة الزاجات انما تحل منها
الملحية مع ما فيها من الكبريتية ثم تعقد وقد استفادت قوة معدن من احد الاجساد فما استفاد من قوة الحديد احمر واصفر كالقلقطار وما استفاد
من قوة النحاس اخضر ولذلك ما امكن ان تعمل بهذه الصناعة واما الزيبق فكانه ماء خالطه ارضية لطيفة جدا كبريتية مخالطة شديدة
حتى انه لا يتعدى منه سطح لا تغشيه من تلك اليبوسة شي فلذلك لا يعلق باليد ولا ينحصر ايضا انحصارا شديدا بشكل ما يحويه بل له ان يثبت على
شكل ما اللهم الا ان يغلب وبياضه من صفاء تلك المائية وبياض الارضية اللطيفة التي فيه ومخالطة الهوائية اياه ومن شان الزيبق ان يعقده روائح
الكباريت ولذلك يمكن ان يعقد بالرصاص او برائحة الكبريت بسرعة فيشبه ان يكون الزيبق او ما يشبهه هو عنصر جميع الذائبات فانها كلها
عند الذوب يصير اليه لكنه اكثر ما يكون دونه يعد المحمي فيرى رسوه محمرا واما الرصاص فلا يشك انه هو هو اذا ذاب انه زيبق لانه لا يدور قبل الحمي واذا حمي
في الذوب كان لونه كلون ساير الذائبات اعني في الحمرة النارية ولذلك ما يعلق الزيبق بهذه الاجساد كلها فانه من جوهرها لكن هذه الاجساد
تختلف تكونها بسبب اختلاف الزيبق وما يجري مجراه في نفسه وبسبب اختلاف ما يخالطه حتى يعقده فان كان الزيبق نقيا وكان ما يخالطه
فيعقده قوة كبريت ابيض غير محترق ولا وسخ بل هو افضل مما يتخذه اهل الحيلة كان منه الفضة وان كان الكبريت مع نقائه افضل
من ذلك وانصع وكان فيه قوة صباغة نارية لطيفة غير محرقة افضل من الذي يتخذه اهل الحيلة عقده ذهبا ثم ان كان الزيبق رديا بالنسبة المحلل
ارضيا وكان كبريته خسيسا ايضا كان منه الحديد واما الرصاص القلعي فيشبه ان يكون زيبقه جيدا الا ان كبريته رديا وغير شديد المخالطة وكانه
مداخل اياه سافا فسافا فلذلك يصر واما الانك فيشبه ان يكون ردي وغير شديد المخالطة وكانه مداخل اياه سافا فسافا فلذلك
يصر واما الانك فيشبه ان يكون ردي الزيبق ثقيله طينه ويكون كبريته رديا منتنا ضعيفا فلذلك لم يستحكم انعقاده وليس يبعد ان
يحاول اصحاب الحيل حيلا يصيرها احوال انعقادات الزيبق بالكباريت انعقادات محسوسة بالصناعة وان لم يكن الاحوال

الصناعية على حكم الطبيعة وعلى صحتها بل تكون مشابهة ومقاربة لذلك يقع التصديق بان جهة كونها في الطبيعة هذه الجهة او مقاربة لها الا ان الصناعة
تقصر في ذلك عن الطبيعة ولا تلحقها وان اجتهدت واما ما يدعيه اصحاب الكيمياء فيجب ان يعلم انه ليس في ايديهم ان يقلبوا الانواع قلبا حقيقيا بل
في ايديهم ان يقلبوا الانواع قلبا حقيقيا بل في ايديهم تشبيهات حسنة حتى يصبغوا الاحمر صبغا ابيض شديد الشبه بالفضة ويصبغوه
صبغا اصفر شديد الشبه بالذهب وان يصبغوا الابيض ايضا اي صبغ شاءوا حتى يشتد شبهه بالذهب او النحاس وان يسلبوا الرصاص
اكثر ما فيهما من النقص والعيوب الا ان جواهرها تكون محفوظة وانما تغلب عليها كيفيات مستفادة بحيث يغلط في امرها كما ان للناس ان يتخذوا الملح والقلقند
والنوشادر وغيره ولا امنع ان يبلغ في التدقيق مبلغا يخفى الامر فيه على الفرهة واما ان يكون الفصل المنوع يسلب او يكسى فلم يتبين لي امكانه
بل بعيد عندي جوازه اذ لا سبيل الى حل المزاج الى المزاج الاخر فان هذه الاحوال المحسوسة يشبه ان لا تكون هي الفصول التي بها تصير
هذه الاجساد انواعا بل هي عوارض ولوازم وفصولها مجهولة واذا كان الشيء مجهولا كيف يمكن ان يقصد قصد ايجاده او افنائه واما سلخ
هذه الاصباغ والاعراض من الروائح والاوزان او كسوها فهذه امور لا يجب ان يصر على جحدها لعدم العلم بها فليس يقوم البتة برهان على امتناعها ويشبه
ان تكون النسبة التي بين العناصر في تركيب كل جوهر من هذه المعدودة غيرها في التركيب الاخر واذا كان كذلك لم يتأد اليه الا ان يفك التركيب ويعاد
اياه الى تركيب ما يراد احالته اليه وليس ذلك مما يمكن بالاذابة التي تحفظ الاتصال وانما تخلط به شيء غريب او قوة غريبة ولنا في هذا كلام طويل لو شئنا
لعملنا لكن الفائدة في ذلك قليلة والحاجة عنه منقطعة في هذا الباب فصل في حال السكونة والمعمورة والبلاد واذ تكلمنا في حال
تكون الجبال وما يحدث في الارض من العيون وما يحدث فيها من الزلازل وما يكون فيها من المعادن فبالحري ان نتكلم في حال السكونة
كيف هي من الارض فنقول اولا انا كنا قد اشرنا فيما تقدم الى ان الواجب بحكم طبيعة الماء والارض ان تكون الارض في ضمن الماء ويكون الماء محيطا
بها من جميع الجوانب ولكن الوجود ليس على ذلك وليس على ما هو طبيعي للارض والماء بل ما هو طبيعي لنظام الكل وذلك انه لما كان من شان العناصر ان
يستحيل بعضها الى بعض وانما كانت الارض لو حدثت على ما هو طبيعي لها لم يثبت لان في طبيعة الارض ان يستحيل اجزاء منها ماء او نارا او غيره
من الجواهر الاخرى وتلك الجواهر المضادة يستحيل منها اجزاء ارضا فما يستحيل من الارض الى غيرها ينقص من جملة حجم الارض فيلزم ضرورة ان
يقع هناك ثلمة في تدوير الارض وغور واذا كانت الارض يابسة لم تجتمع الى شكلها الطبيعي بل يبقى عليها الشكل المستفاد وما يستحيل الى الارض يكون
لا محالة زيادة ونتوءا ملتصقا بها فلا ينبسط عليها انبساط الماء المهراق على ما غيره حتى يصير منها حجم واحد مستدير فيلزم ضرورة ان يتولد على كرة الارض
تضاريس من غور ونجد وخصوصا وللكواكب الاوج تاثير في ايجاب هذه الاحالة بحسب المسامتات التي تميل الى الجنوب مرة وخصوصا الثوابت
تارة والى الشمال تارة والاوجات والحضيضات المتغيرة في الكمية فيشبه ان تكون هذه اسبابا عظاما في احداث اليابسة في جهة او تعظيمها
فيها وابطال اليابسة من جهة ونقلها عنها او نقل اليابسة من جهة الى جهة انما يكون بتوسط احداث اليابسة في جهة واعدامها من جهة واحدة لها
يكون بسيل الرطوبة تصعد اليها بالسيل الى جهة خاصة من الارض وان كل واحد منها يعظم ويكثر على الدهر حتى يؤثر في الهيئة شكل الماء لسيلان الماء الى
الغور وكشفه للنجد وقد يعان على هذه اسباب اخرى اذ لا بد من حدوث طين بين الماء والارض ولا بد من نفوذ قوة الشمس والكواكب الى الطين
وتحجره اياه اذا انكشف حتى يتخلق الجبال على ما قلناه واذا كان كذلك لم يمتنع من ان يكون يرد يجري في ذلك حكم الالهية لولاها لم يكن للحيوانات الارضية ان

تعيش

If the mercury be pure, and if it be commingled with and solidified by the virtue of a white sulphur which neither induces combustion nor is impure, but on the contrary is more excellent than that prepared by the adepts, then the product is silver. If the sulphur besides being pure is even better than that just described, and whiter, and if in addition it possesses a tinctorial, fiery, subtle and non-combustive virtue—in short, if it is superior to that which the adepts can prepare—it will solidify the mercury into gold.

Then again, if the mercury is of good substance, but the sulphur which solidifies it is impure, possessing on the contrary a property of combustibility, the product will be copper. If the mercury is corrupt, unclean, lacking in cohesion and earthy, and the sulphur is also impure, the product will be iron. As for tin, it is probable that its mercury is good, but that its sulphur is corrupt; and that the commingling [of the two] is not firm, but has taken place, so to speak, layer by layer, for which reason the metal shrieks. Lead, it seems likely, is formed from an impure, heavy, clayey mercury and an impure, fetid and feeble sulphur, for which reason its solidification has not been thorough.

There is little doubt that, by alchemy, the adepts can contrive solidifications in which the qualities of the solidifications of mercury by the sulphurs are perceptible to the senses, though the alchemical qualities are not identical in principle or in perfection with the natural ones, but merely bear a resemblance and relationship to them. Hence the belief arises that their natural formation takes place in this way or in some similar way, though alchemy falls short of nature in this respect and, in spite of great effort, cannot overtake her.

Mercury seems to be water with which a very tenuous and sulphureous earth has become so intimately mixed that no surface can be separated from it without something of that dryness covering it. Consequently it does not cling to the hand or confine itself closely to the shape of the vessel which contains it, but remains in no particular shape unless it is subdued. Its whiteness is derived from the purity of that aquosity, from the whiteness of the subtle earthiness which it contains, and from the admixture of aeriness with it.

A property of mercury is that it is solidified by the vapours of sulphureous substances; it is therefore quickly solidified by lead or by sulphur vapour. It seems, moreover, that mercury, or something resembling it, is the essential constituent element of all the fusible bodies, for all of them are converted into mercury on fusion. Most of them, however, fuse only at a very high temperature, so that their mercury appears red. In the case of lead, an onlooker does not doubt that this is mercury, since it melts at a lower temperature, but if during the fusion it is heated to the high temperature [mentioned above], its colour becomes the same as that of the other fusible bodies, i.e., fiery-red.

It is for this reason, *viz.* that it is of their substance, that mercury so easily clings to all these bodies. But these bodies differ in their composition from it by reason of variation in the mercury itself—or whatever it is that plays the same part—and also through variation in what is mixed with it and causes its solidification.

CHAPTER III

IN WHICH ARE SET FORTH TREATISES UPON THE BEHAVIOUR OF QUICKSILVER

BY

SCIENTISTS OF THE HOLY ROMAN EMPIRE

Little is known of VANOCCIO BIRINGUCCIO, author of *De la Pirotechnia,* except that he was a mathematician and metallurgist trained in part in Germany. Of himself he says, "I have no knowledge other than that gained through my own eyes." The first edition of his metallurgical work was published posthumously in Venice in 1540, and was followed by four other Italian editions (1550, 1558-59, 1559, 1678). An English translation by C. S. Smith and M. T. Gnudi was released in 1942. Pages reproduced herein are from a copy of the 1540 edition in the collection of the Lane Medical Library of Stanford University.

GEORGIUS AGRICOLA [Georg Bauer], 1490-1555 is known today as the "father of metallurgy." Until the middle of the 18th century, his book *De re metallica* was the treatise for miners and metallurgists, passing through ten editions in three languages. This great work was based largely upon his own observations made at Joachimstal, a German mining and smelting center, where he spent many years as a practising physician. Pages reproduced herein are from a copy of the 1657 edition in the collection of the State Division of Mines. English translation is from *Georgius Agricola De re metallica Translated from the first Latin edition of 1556 . . . by Herbert Clark Hoover . . . and Lou Henry Hoover, 1950,* and is quoted by permission of Mr. Hoover. The translation was first published by *The Mining Magazine, London,* in 1912.

LAZARUS ERCKER, German metallurgist, chief superintendent of mines and comptroller of the Holy Roman Empire and Kingdom of Bohemia, was the author of a third great metallurgical treatise published during the 16th century. His work, *Aula Subterranea . . . . das ist: Untererdische Hofhaltung,* has gone through at least eight German editions, three English editions (17th century), and one Dutch edition. A modern English translation, *Lazarus Ercker's Treatise on Ores and Assaying, Translated from the German Edition of 1580,* by A. G. Sisco and C. S. Smith, was published in 1951. The extracts reproduced herein are from a copy of the 1672 edition of *Aula Subterranea* in the collection of the University of California Library, Berkeley; and from the English translation by John Pettus (1683) in the collection of the State Division of Mines.

DE LA PIRO-
TECHNIA.

LIBRI. X. DOVE AMPIAMEN
te ſi tratta non ſolo di ogni ſorte & di-
uerſita di Miniere, ma anchora quan
to ſi ricerca intorno alla prattica di
quelle coſe di quel che ſi appartiene
a l'arte de la fuſione ouer gitto de me
talli come d'ogni altra coſa ſimile à
queſta. Compoſti per il. S. Vanoc-
cio Biringuccio Senneſe.

Con. Priuilegio Apoſtolico & de la
Ceſarea Maeſta & del Illuſtriſs. Sena
to Veneto. M D XL.

VANOCCIO BIRINGUCCIO
1540
Translation by GERALDINE E. MARTINO, 1953

On Quicksilver and Its Mining

Quicksilver is a body of fluid and liquid matter, almost like water, with a shining whiteness, composed by nature of a viscous and subtile substance, with a superabundance of humidity and frigidity together; which composition, according to the opinion of the alchemists, is something very disposed to become metal. They even consider it to be the original seed of all metals, which, lacking the warmth and dryness necessary or the time needed to coagulate, remains thus in the substance which we see, without the form of metal, and is imperfect. And even these subtile investigators, considering certain of its reactions, have called it mercury—perhaps because of the similarity to the power of the planet of Mercury, whom poets in their fables want placed between the gods and men. Thus even these wish it to be placed among the perfect metals, making it primary mineral matter; and perhaps it may be that they call it thus because like him it is winged and flies, and by virtue of its powerful volatility penetrates all things as does the god Mercury, and can escape from wherever it is placed. Now let them call it by whichever name they wish, for it does not matter to us. I will call it either mercury or quicksilver, according to their pleasure, and you will understand it as such.

Leaving now the arguments as to whether it is primary mineral matter or not, for enough has been said on this subject in the first chapter of the first book, I will say here, in order to approach that which is said of it by the philosophers, that it could be matter about to convert itself into metal; but seeing it so poorly proportioned and so unstable, I cannot believe it to be the generator of all kinds of metals; and moreover, it seems to me that if it were, it would be more likely, if uninterrupted, to generate lead or tin or iron, or even silver, rather than copper or gold. Considering it in relation to its aspects, or even in relation to the power of planets far distant from those of gold, from the power of the sun or moon, it seems to be mercury. And therefore I say, if it is not as I have said, it is a thing which nature was pleased to make in the form in which she made it, and I say this because I see it always in the same form and of the same quality. The alchemists hold the aforementioned opinions, and wish in every way that they be true: that it may be a defect of nature, in order that they may help her with their art. Because of this they are in a continual agitation of mind and body, trying to furnish that which nature has failed to supply, in order to bring it to its perfection. Over this are born endless opinions and arguments, because some believe one thing and others something else. Thus they remain without decision, in the midst of valorous battle. Some are in favor of metallic stability, wishing to deprive it of every vital spirit; and because of this they bury it in poisons or in poisonous herb juices; and there are those who would drown it in corrosive and powerful acids; and those who would with ingenious ways convert it by fire into dry lime; and, in short, there are those who want it done one way, and those who want it done another way. Again, there are those who distrust and hate it, and will have nothing to do with it; and others are of the opposite opinion, and their faculties and time and every hope are bent on following it, so that he who considers the many viewpoints finds a confusion of

intellects—it is a game and a trifling of the alchemistic crowd. As I have already said, they are always around, trying to break it down, now seeking with various flatteries and tricks, and now with force and various ingenious ways, to imprison it in very close quarters, or to wall it in, or to chain it with irons or other strong chains; and others, with various chastisements and blows then, since they cannot make it die, try to break its bones and cut off its wings in order to remove all the strength of its powerful flight, so that at times the poor one finds himself in serious difficulties. Yet in the end—being numbered among the gods and having in himself divine strength, and also being winged—when he is in the midst of his greatest danger, he frees himself from their strong bonds, and fleeing from the hands of his crucifiers, flies to heaven and, laughing scornfully at his ridiculous adversaries, leaves them with their decanters and their purses empty. By this means it declares its nature and demonstrates to us its wateriness and volatility, with the result that even though it be not pursued by the heat of fire, it finds by its own instinct the smallest exit. Similarly, if said mercury, to conserve it, is placed in whatsoever metal vessel, although it does not contain saltiness and is by nature cold and humid, it easily gnaws and bores through and escapes, though it should not do so, condensing as it does by cold and humidity, and becoming very weak and impotent. There are those who say it shows itself to have a warm property because of certain of its results, as used in medicine.

Among its other notable operations is the fact that all metals placed in a vessel containing mercury are kept in suspension, floating like something light—

DE LARGENTO VIVO ET SVAMINIERA.
CAPITOLO PRIMO.

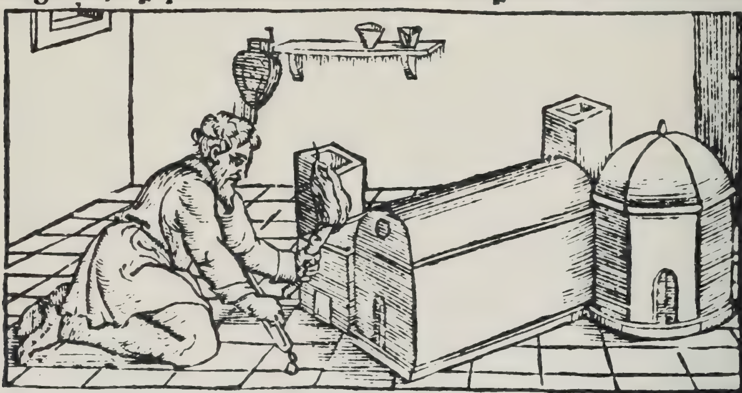
LARGENTO viuo vn corpo di materie fluē-
ti & liquidi quaſi come quel del acqua,c on vna lucē-
ti bianchezza,compoſto da la natura di ſuſtantia vi-
ſcoſa & ſottile,con molta ſopra abundantia d'humi-
dita, & frigidita inſieme, ilqual compoſito ſecondo
l'oppinione de filoſofi alchimici e coſa molto diſpo-
ſta a metallificare, Anzi dicano eſſer original ſeme
di tutti metalli,ilquale per mancharli la calidita & la ſiccita debita,o il
tempo determinato che ſe gli ricercha nō puo coagularſi, & reſta coſi
nel leſſer chel vediamo ſenza la forma di metallo & come coſa īpſetta.
Et ancho queſti ſuttili inueſtigatori per certi effetti chan conſiderato di
lui,lhan chiamato mercurio,forſe per la ſimilianza del ſuo pianeta, in
quelli effetti delquale li poeti fabulizando vogliano che ſia mezzo in-
fra gli dei & gli homini.Coſi anchor queſti vogliano che ſia queſto in-
fra li metalli perfetti facendoſi prima materia minerale,& forſe anchor
eſſer potrebbe che coſi il chiamaſſero per eſſer come lui alato & fuggi-
tiuo,& per virtu dela ſua ſottigliezza potente a penetrare in tutte le co
ſe come fa lo iddio mercurio, & aduſcir anchor a ſua poſta doue glie
meſſo.Hor chiamaſi queſto per quel nome che vogliano che a noi nō
importa,chiamarollo anchio come loro quādo mercurio & quando

argento viuo secondo che mi verra detto, & voi lintenderete per tale. Et lassando hor le dispute da pte seglie prima materia de metalli o no, per hauer di tal dubio nel capitolo primo del primo libro ditto assai. Diro qui per acostarmi a quel che di lui dicano li filosofi, che esser potrebbe chel sia materia prossima a cõuertirsi in metallo, ma p vederla tanto mal pportionata & mal decotta creder nõ posso che esser possa disposta alla generatiõe di tute le spetie de metalli, Et che se di pur fusse mi pare che la fusse in via se nõ gli fusser stadi interotti gli debiti mezzi piu a generar il piombo o lo stagno, o'l ferro o pur largento che non il rame o loro, & se considerare il vogliamo per via dele cõplessioni naturali, o pur per il poter de pianeti molto lontano da quelle del oro, & dal poter del sole o dela luna mi par mercurio. Et pero diro se non e quel chio ho detto, esser cosa che la naturn glie piaciuto di fare quel che l'ha fatto, & questo mel fa dire el vederne sempre quanto n'ho veduto esser duna medesima forma & duna qualita medesima. Gli alchimisti son quelli nelle oppenion sopradette che vogliano in ogni modo chel sia vero chel sia vn defetto dela natura per poter sperare con la lor arte succorarlo. Et per questo stanno in cõtinua agitatione di mente & di corpo in veder datutarlo & di supplire al bisogno di quel che la natura ha manchato per cõdurlo alla sua perfettione sopra delaquale cosa per trouarne la via naschano infiniti pareri & dispute, p che e chi di lui credi vna cosa & chi vnaltra, & cosi stan sospesi senza resolutiõe in trauaglioso cõbattimẽto, & alcuni sonno che per dargli la fissation metallica il voglino hauer chel sia prima dogni vitale spirito priuo, & p q̃sto chil sotterra in veneni, o in venenosi suchi d'herbe, & chi la nieggano in gli corrosiue & potenti acque acute, & chi vol che dal fuocho cõ ingeniosi mezzi in arida calcina sia cõuertito, & in summa chil vuol cõcio in vn modo & chi in vnaltro. Et tale anchora e di questi che diffidato di lui l'ha odioso, & pratticare doue lui interuenga p alcun modo nõ vuole, & alcuni altri sonno d'opposito parere, & le faculta el tempo & ogni lor speranza metteno in seguitarlo. Talche chi ben considera el fatto suo e vna confusion d'intelletti, Anzi e vn giuocho & vna ciuetta dela turba alchimisticha, alqual come ho detto sempre stanno intorno per volerne far anathomia, hor cercãdo con varie lusinghe & inganni & hor con forza & varii ingegni di mettarlo in strettissime carceri, o murarlo, ouer con ferri, o altre forte catene incatenarlo, & alcuni altri sonno che con varii caschamẽti & botti, dapoi che morir far nol possano, cerchan de fiacchargli lossa, & troncãdogli lale per leuargli ogni vigor del suo possente volare. Talche alle volte il pouerello si troua in assai mal partito. Pur al fine per esser del numero degli dei, & hauere in se vigor diuino, & ancho per esser alato allor dispetto quãdo il vede piu esser nel mezzo del suo maggior pericolo per saluar la vita, d'ogni lor

forte legame si sciogle, & fuggendo delle man de suoi crucifissori sene vola in cielo, & quasi ridendo li suoi aduersarii tutti sbeffati & schernidi lassa cō le boccie & lor borse vacue. Per ilquale effetto ci si dichiara la sua natura, & ci si dimostra la sua aquosita & sottigliezza, laquale e con effetto tale che anchor che la nō sia cacciata dal calor del fuocho troua per suo ꝓprio istinto doue e messa l'uscita ꝑ ogni picolissimo poro, & āchor similmēte se ꝑ cōseruarlo e messo detto mercurio ī qual si voglia vaso di metallo, ben che nō cōtenga salsedine, & sia di natura fredda & humida facilmente rodendo il fore & trapassa, ilche far gia nol douerebbe condensandosi per il freddo & lhumido, & facendosi debile grosso & impotēte. Anchor che cie chi vuole che per certi suoi effetti, come nela medicina dimostra habbi proprieta calida. Ha anchora infra laltre sue operation notabili questa chogni metallo messo in vn vaso doue ne va quātita sopra di se, come cosa leggiera el tien suspeso, & portando il fa callare. Saluo loro quale in scambio di suspēdarlo la braccia & tira in se per fino al fondo, & ad ogni altra cosa senza il mezzo del arte anchor chel sia liquido & humido nō si congiogne ne accosta, & per hauer in se la sua humidita con la viscosita ben mista, non la lassa. Chiamasi questo argento viuo, ꝑche di color somiglia largēto, & viuo per che cosi come e si troua nele miniere & si mantien, & e cosa mobile come vediamo, & perche difficilmente si mortifica, & sublimādolo senza compagnia saglie tutto nel collo dela lutel o boccha, ouer altro vaso in chel si sublimi senza lassare nel fondo terrestita alcuna, & senza rimouer la sua forma, & ancho senza quasi diminuir di peso se gia con molto calor di fuocho non lostregneste. Ilche auiene che quella sustantia terrea chi e in esso e benissimo assottiglata, & con l'humido viscoso benissimo mista. Tal che quando il fuocho come suo cōtrario lo caccia per hauere la natura tal sustantie legate insieme con se luna porta laltra, & anchora che di sopra v'habbi detto in general de la sua bianchezza. Vi dico secondo l'oppinione d'Auicenna venire da la molto sua aquosita & terrestita suttile decotta con molto aere. Son molti che per vederlo cosi liquido & chiaro & quasi in forma dacqua han detto esser pura acqua che dal caldo del solfo e stata alquanto ristreta & decotta. Ilche e fallo, ꝑche lacqua pura e impossibile che con nissun caldo mai si stringa. Ma se dicessero cō la molta fredezza intrinseca di se medesimo o esteriore direbben forse meglio. Hor per concludere e questo tal composito cosa assai nota, & massime agli alchimisti adoperasi a molte cose in medicina per la frigidita sua. E notato infra il numero di veneni, ha proprieta di contrare li nerui a quelli artifici che lo estranno dela miniera se non son molto cauti, & a quelli che longamente maneggiando il practicano, fa tutti li lor membri debili e paralitici. Fassi con esso mescholato col solfo, dipoi sublimato il cinabro, & similmente anchora mescholato col sale armoniacho si fa

quello che propriamente per il vulgo ſi chiama ſolimato, o vero argento ſodo, ilquale e vn materiale biancho & lucido, come propria nieue, corroſiuo molto & mortifero veneno dela vita, faſſene anchora molti altri effetti, che ſarebbe coſa troppo longa a volergli tutti particularmente narrare. PERO LASSANDOLI vi diro qui hora come la ſua miniera ſi troua, delquale per ilche e da ſapere che la piu ſi caua ne monti, & in quei luochi doue piu linfluſſo di mercurio influiſce, o pur doue la terra e piu diſpoſta, come anchora interuiene a tutte laltre miniere. Generaſi queſto comunemente in vna pietra biancha mortigna, o vero in vnaltra biancha ſimile a vna calcina, & anchora ſene troua molte volte in vn ſaſſo roſſo ſcuro quaſi come vn cinabro, & tutto come vna pomice ſpognoſo, neliquali buſeti di ſpognoſita viſi genera come gocciolline proprie dacqua. Delquale quanto piu vi ſene vede infra eſſa, tanto e la miniera migliore, & ſe in detta pietra appariranno machie come muffa alquāto bigie, ouero azurre ſara la miniera magra, TVTTI LI MONTI o luochi doue la ſi genera ſon copioſi dacqua & d'arbori, & l'herbe vi ſon verdisſime. Perche ha con ſe freſchezza, & non vapora ſiccita come fa il ſolfo, il vitriolo, el ſale, & ſimili. Ma e ben vero che gli arbori che vi ſonno non producano fiori, & ſe gli producano non conducono a maturita gli frutti. In la prima vera metteno le foglie piu tardi che negli altri luochi, che per la freſchezza deſſo douerrien fare al contrario. Cognoſcesſi doue queſto ſia el meſe de Aprile, o del Maggio, la mattina auanti il leuar del ſole quando li tempi ſon tranquilli & quieti, a certi vapor grosſi & denſi, che ſopra a quel luocho ſi eleuano, ma per eſſer graui non arriuano molto in alto, & alcuni che hanno di tal coſa iſperientia, vanno per tal ſegnale, come ſi fa del lacque quaſi apposta a trouarlo, & dicano che ſe tal miniera e volta verſo el vento ſettentrionale eſſer perfettisſima. Gli alchimici dotti chiaman queſto mercurius vulgi, diſprezandol molto nele loro operationi con dir a confirmation di quel che v'ho detto, che non e quello che la natura adopera in generar li metalli. Ma non credo gia che mi poſſin negare che ancho in eſſo di quel che voglian dire non ne ſia la ſua parte. Per ilche aſſai mi marauiglio che per hauerne eſſendone tanto in vn come nel laltro el vadin cercando fra le ſuſtantie del ſaturno metallo terreſte rubiginoſo & imperfetto. Et in quella materia doue e piu propinquo il lasſino, anzi forſe ſi come molti vogliano e quella propria che genera q̃lla coſa, nelaquale il van cercando. Hor ſel trouano o no, & in che coſa il trouino a lor mi reporto. Et tornando al camin nr̃o dico, che trouato di q̃ſto la miniera in molti modi ſene cibrae. Et eſſen-

do generato in pietra spognosa dela sorte che ho detto disopra, si macina con pistoni benissimo, o con mulino da vliuiera che la schiacci, & dipoi si laua. Ma seglie in pietra ben cõmista, sonno alcuni che fanno vna stanzetta piccola con vna volta abbotte, ouero a catino nõ di molta grandezza, ma benissimo intonicato, & disotto fanno vno spazzo che penda alquanto in verso il mezzo, nettamente murato, & dacãto dentro alla grossezza del muro, fanno vno o piu fornelli in tal modo adattati, che le bocche per lequali s'ha da dar fuocho venghin fuor de la stanza & sopra alli fornelli vi muran dentro tanti pignati quãti ne possan cõtenere, & gliempino di detta miniera in poluere, o redutta in molti pezzetti. Et dipoi infra la volta dela stanza & lo spazzo fanno vno infraschato di frasche darbori verdi & serran bene la finestretta & lentrata che niente ne possa respirare, & dipoi dan fuocho alli forni, & cosi il mercurio sentendo il caldo del fuocho come suo cõtrario vuol fuggire, & euaporando saglie & esce fuor dela boccha de vasi, quale p sentire certa freschezza che porgen le foglie di quelle frasche a esso cõforme corre e esce & vi sattacha sopra. Per il che dipoi quando il pratico artifice pensa o crede che dela sua materia che misse ne pignati la sustantia del mercurio sia tutta vscita, lassa spegnare il fuocho & il tutto benissimo refreddare, & dipoi entra ĩ detta stanza, & anchor chel mercurio per la sua ponderosita da perse dele frasche doue e attaccato caschi buona parte nelo spazzo scrullano le predette frasche, & quel che non fusse caschato il fan caschare, & dipoi nettamente dalo spazzo il ricoglieno, & p questo modo van cõtinuando p fin che hãno miniera,

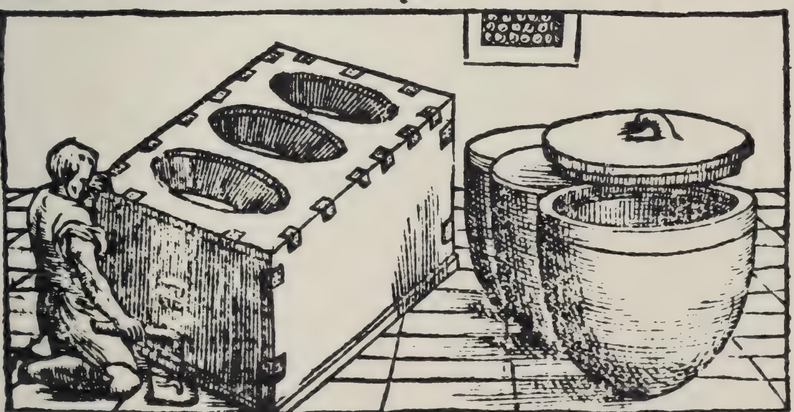


Alcuni altri sonuo che lo istraggano con mancho trauaglio cõ pignatte di terra grãdi cõmesse che cõmettino le bocche luna nel latra, & empita la pignatta maggiore di miniera vi metteno sopra vn pian d'arena, ouer di cennere stacciata, accioche sagliẽdo largẽto viuo spento dal fuocho nel lakra pignatta sopra a posta tornando indricto congionto in

goccie

gocce come acqua caschi sopra a tal cennari, ouer arene, & fredda che sara la pignatta. dipoi lauandolo facilmente doue il sia si ricupera.

Alcuni altri sonno che in scambio di pignatti fan certi vasi di terra larghi in boccha, & stretti in fondo come son le forme daffar gli zucchari, aliquali fanno vn coperchio cõmesso grosso vn dito o piu di terra & il vetriano dentro, & questo tal vaso empieno di miniera pesta o trita benissimo, & sopra copreno de vn dito o due di cennare stacciata, & sopra col coperchio serrano benissimo il vaso legandolo, ouero cõ qualche cosa graue che gli calchi disopra con aggrauãdolo, & dipoi mette fuocho al fornello done sonno adiutati a star dentro detti vasi, & cosi per sentire il caldo il mercurio esce dela miniera & saglie per voler euaporare, & percotendo neli coperchi, cascha infra le cennari come nel laltro modo sopradetto, da lequali come hauete inteso, lauandole o cõ staccio fitto stacciandolo tuto si ricupera.



Alcuni altri m'han detto hauer veduto mettere in scambio di tal coperchio & cennare vn vaso simile a quello che si chiama campana da

L. S. DELA. P.

distillare, che col suo canale ricoglie quel che si conuerte in mercurio, & col suo becco longo lo porta nel recipiente. Et cosi empito di minera pesta il vaso di sotto, & con laltro di sopra ben coperto & acócio mette nel fornello il fuocho, & fan salire il mercurio in quel di sopra, & come se fusse acqua tutto quel che nesce entra nel recipiente. Et cosi se mai trouasse di tal minera che cóporti la spesa, andarete di qsti modi usando quel che con la sperientia vederete, che visia per seruir megho.

with the exception of gold, which, instead of being suspended, is embraced and drawn into it to the very bottom. It does not join with or approach any other thing even though it be liquid and humid, without the assistance of art; and because of its intrinsic well-blended humidity and viscosity, does not leave gold.

We call this quicksilver because it resembles silver in color, and quick because it is found thus in the mines; and we maintain that it is a moving thing and difficult to mortify. If sublimated alone, it rises from the neck of the aludel, or from the mouth, or from some other vessel in which it is sublimated, without leaving any residue at all at the bottom, and without changing its form, or with practically no loss of weight unless forced by strong heat. This happens because that earthy substance in itself is very well blended with humid viscosity, so that when fire as its opposite drives it out, nature having tied these substances together, one carries the other. Although I have already told you in general of its whiteness, I tell you that according to the opinion of Avicenna, it comes by this from its wateriness and subtile earthiness decocted with much wind. There are many who, having seen it so liquid and clear, and almost in the form of water, have said it to be pure water which has been somewhat condensed and decocted by the heat of the sulfur. This is false, because pure water cannot be condensed by heat; but if they were to say by the great intrinsic coldness of itself or the exterior, they might be more correct. In conclusion: its composition is a thing well noted by the alchemists, and it is employed in many ways in medicine because of its frigidity. It is noted among the number of poisons. It has the property of contracting the nerves of those workers who extract it from the mine, if they are not extremely careful; and those who handle it a long time find that their limbs become weak and paralyzed. Mixed with sulfur

and then sublimated it makes cinnabar; and similarly mixed with sal ammoniac it makes that which is commonly called sublimate or true hard silver, which is a white and shining substance like snow, a very corrosive and deadly poison. It has many other characteristics which would take too long to tell about in detail.

But leaving them now, I will tell you how the mine is found. One must know that most of it is dug out of mountains and in those places where the influence of mercury holds sway, or yet where the earth is most disposed, as happens in the case of all other mines. Usually it is generated in a soft white stone, or in another white stone similar to lime. Also, much of it is found in a dark red stone, almost like cinnabar and similar to a spongy pumice stone, in whose vesicles it is generated like tiny drops of water. The more one sees of this, so much the better is that mine; and if in said stone there should appear somewhat gray or blue stains like mold, there the mine will be a poor one. All of the hills or places where it is generated have abundant water and trees, and the plants are very green because of the freshness within itself, for it does not exhale dryness as do sulfur, copper sulfate, salt, and other similar minerals. But it is true that the trees that are there do not produce flowers; and if they should flower, the fruit does not mature. In springtime their leaves come later than those in other places, although because of the coolness here, they should do the opposite. In the month of April, or of May, in the mornings before the sun rises, when the weather is tranquil and calm, we can discern (where the quicksilver is to be found) by certain large and dense vapors which rise over the place; but being heavy they do not rise very high. And some who have experience in this go by such a sign, as one does when searching for water; and they say that if such a mine faces the north wind it will be an excellent one.

The learned alchemists call this common mercury, or *mercuris vulgi*, disdaining it in their work, confirming that which I have told you: that this is not the one which nature employs in producing metals; but I do not believe they can deny that even in this there be some part of it. I marvel that in order to have it, there being as much in the one as in the other, they search for it among the substance of Saturn, which is an earthy, rust-colored, imperfect metal; yet in the material where it is most likely to be found, they leave it—perhaps because, as many want to believe, it is precisely this material that generates the thing in which they search for it. Now if they find it or not, and in what thing they find it, I leave it to them.

But to continue: I say that we find that the ore is extracted in many ways. And being generated in a spongy stone of the kind above mentioned, it is ground very fine with pestles or in an olive mill, which breaks it; and then it is washed. But if it is well mixed in the stone, there are those who make a small room with a ceiling domed like a barrel, or like a basin which is not very large, but very well plastered. And below this they make a floor that slants somewhat toward the middle, neatly walled; and on one side, within the confines of the walls, they make one or more small furnaces, placed in such a way that the mouths by which fire is applied extend outside the room. And above the ovens they build in many kettles, as many as can be contained, and they fill them with said ore in powder form, or reduced to many small pieces. Then, between the ceiling of the room and the floor, they make a pile of branches of green trees, and they

seal the small opening of the entrance so that nothing may be exhaled, and then they fire the furnaces: and thus mercury, feeling the heat of the fire as its opposite, wishes to flee; and, evaporating, it rises and comes out of the mouths of the vessels; and feeling the coolness that the leaves of those branches afford, is attracted, and emerges and attaches itself to them.

When the experienced workman thinks or believes that all of the substance of mercury has been extracted from the ore that he placed in the kettles, he lets the fire die and the whole thing become cool. Then he enters said room, and although a good part of the mercury because of its weight has fallen of itself from the branches where it was adhering, he shakes the branches, and makes that which did not fall, fall. And then he neatly recovers it, and in this manner continues as long as there is ore.

Others extract it with less work with large earthenware kettles. They place the mouths one on the other, and, filling the larger kettle with ore, they place over it a layer of sand or of sifted ashes; so that the quicksilver, rising exhausted from the heat of the fire into the kettle placed above, comes back in the form of water-like drops, falling on the ashes or the sand. And when the kettle cools it is easily washed and recovered.

There are others who, instead of kettles, make certain earthenware vessels with large mouths and narrow bottoms like the sugar molds; for these they make a cover a finger or more thick, and they glaze the inside. The vessel is filled with ore well ground or pounded, and they cover this with a finger or two of sifted ashes; and over all of this they place the cover, sealing well the vessel by tying it on, or placing something heavy on top of it. And then they fire the furnace where these vessels have been placed, and when the mercury feels the heat it issues out of the ore and rises because of its desire to evaporate; and hitting the covers, it falls back among the ashes as in the other method above mentioned.

Others have told me of having seen used, in place of a lid and ashes, a vessel similar to that which is called a distilling bell, which with its channel recovers that which is converted into mercury, and with its long beak carries it to the receptacle. And thus, with the lower vessel filled with ground ore, and the other above well covered and sealed, the furnace is fired, and mercury rises into the one above; and as if it were water, all that which issues forth flows into the receptacle.

And thus, if ever you should find such a mine that is worth the expense, by using these methods you will be doing that which experience shows may serve you best.

GEORGIUS AGRICOLA
1556

Translation by HERBERT CLARK HOOVER and LOU HENRY HOOVER, 1912

Quicksilver ore is usually tested by mixing one part of broken ore with three parts of charcoal dust and a handful of salt. Put the mixture into a crucible or a pot or a jar, cover it with a lid, seal it with lute, place it on glowing charcoal, and as soon as a burnt cinnabar colour shows in it, take out the vessel; for if you continue the heat too long the mixture exhales the quicksilver with the fumes. The quicksilver itself, when it has become cool, is found in the bottom of the crucible or other vessel. Another way is to place broken ore in a gourd-shaped earthen vessel, put it in the assay furnace, and cover with an operculum which has a long spout; under the spout, put an ampulla to receive the quicksilver which distills. Cold water should be poured into the ampulla, so that the quicksilver which has been heated by the fire may be continuously cooled and gathered together, for the quicksilver is borne over by the force of the fire, and flows down through the spout of the operculum into the ampulla. We also assay quicksilver ore in the very same way in which we smelt it. This I will explain in its proper place. . . . .

I will first speak of quicksilver. This is collected when found in pools formed from the outpourings of the veins and stringers; it is cleansed with vinegar and salt, and then it is poured into canvas or soft leather, through which, when squeezed and compressed, the quicksilver runs out into a pot or pan. The ore of

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Venam vero argenti vivi ſic experiri convenit: cum parte una fragmentorum ejus tres partes pulveris carbonum, & manipulum ſalis commiſceto: miſturam in catinū, vel ollam vel urceum injicito, operculo tegito: luto oblinito: in carbones ardentes imponito, poſtquam ei inſederit uſtę color, catinum extrahito: nam ſi diutius ipſum coxeris, miſturá argentum vivum, uná cum fumo exhalat: quod ipſum in fundo catini vel alterius vaſis refrigerati invenitur. Aut venam ejus tritam injicito in vas fictile cucurbitinum, & id in fornaculam imponito, atque operculo, cui longa eſt naris, contegito: nari autem ſupponito ampullam, quæ recipiat argentum vivum, quo ipſa ſtillat: ſit veró aqua frigida in ampullam infuſa, ut argentum vivum igni concalefactum continuó refrigeretur & confluat: nam argentum vivum vi ignis in ſublime fertur, & per operculi narem in ampullam defluit. Experimur etiam venam argenti vivi eodem plané modo, quo eam excoquimus, quem ſuo loco explicabimus.

GEORGII AGRICOLAE
KEMPNICENSIS MEDICI AC
PHILOSOPHI CLARISS.

DE RE METALLICA
LIBRI XII.

QUIBUS OFFICIA, INSTRUMENTA, MACHINÆ, AC OMNIA DENIQUE AD METALLICAM SPECTANTIA, NON MODO' LUCULENTISSIME' deſcribuntur; ſed & per effigies, ſuis locis inſertas, adjunctis Latinis, Germanicisq́ue appellationibus, ita ob oculos ponuntur, ut clariùs tradi non poſsint.

Quibus acceſſerunt hác ultimâ editione, Tractatus ejusdem argumenti, ab eodem conſcripti, ſequentes.

De Animantibus Subterraneis. Lib. I.
De Ortu & Cauſis Subterraneorum. Lib. V.
De Natura eorum quæ effluunt ex Terra. Lib. IV.
De Natura Foſsilium. Lib. X.
De Veteribus & Novis Metallis. Lib. II.
Bermannus ſive de Re Metallica, Dialogus. Lib. I.

Cum Indicibus diverſis, quicquid in Opere tractatum eſt, pulchrè demonſtrantibus.

BASILEÆ,
Sumptibus & Typis EMANUELIS KÖNIG.
ANNO M. DC. LVII.

Reliquorum autē metallorū venę in fornacib. nō excoquūtur, ſed argēti vivi, ut etiā ſtibii, in ollis: plumbi cinerei, in canalib. Sed primò dicā de argento

F 4

[illegible] lacunis, in quas ex venis fibrisq; confluxit, repertum colligatur: [illegible] purgetur: in linteum lino xylino contextum, vel in alutam infun[illegible], per quam complicatam & compressam argentum vivum penetrans [illegible] in ollam vel patinam subjectam delabitur. Vena vero argenti vivi in [illegible] excoquitur binis vel singulis: si in binis, superiores figura non multum dissimiles sunt vitreis ampullis, in quas urinæ, medicis inspectandæ, infundi solent: continuò tamen recta sursum versus angustiores. Inferiores vero similes sunt catillis, in quibus viri vel mulieres caseos conficiunt: sed utræque utrisq; majores. Inferiores usq; ad margines in terra vel arena, vel cinere defodere oportet, in superiores venam in particulas fractam injicere, easq; completas obturare musco, & inversas in ora inferiorum imponere, qua conjunguntur oblinire luto, ne argentũ vivum, quod in eas confugit, exhalet. Quanquam sunt qui, propterea quod defossæ sint, nihil tale metuentes eas non oblinunt: quiq; glorientur se non minus argenti vivi pondus conficere quàm eos qui ipsas oblinunt: veruntamen oblitę luto ab exhalando magis tutę sunt: quo sanè modò septingenta ollarum paria in solo vel foco collocentur, & undique mistura, quæ constat ex pulvere terræ comminutæ, & à carbonibus resoluto, circumfundantur, ut ex ea superiores palmum modo extent: ad utrumque foci latus saxa prius posita sint, eisq; superimposita tigna, quibus operarii longa ligna injiciant trãsversa. Etsi verò ligna non attingunt ollas, acris tamen ignis ardor eas calfaciens argentum vivum caloris impatiens per muscum in ollas inferiores defluere cogit. Nam si vena excoquitur in superioribus ollis, de eis, quà datur exitus, fugit in inferiores: si contrà in inferioribus, fertur in superiores, vel in opercula, quæ simul cum vasis cucurbitinis ollarum superiorum locum obtinent. Sed ollæ, ne vitium faciant, ex optima argilla finguntur: si enim vitium fecerint, argentum vivum ex eis unà cum fumo evolat: qui si magna dulcedine odoratum commoverit, id ipsum consumi significat. Quoniam verò is dentes mobiles efficit, excoctores & cæteri astantes hujus mali admoniti terga obvertunt in ventos, qui fumum in contrariam partem pellunt. Etenim officina circa frontem atq; latera patere, & ventis exposita esse debet: tales autem ollæ, si ex ære caldario factæ fuerint, in longum tempus in igni poterunt durare. Hæc ratio venæ argenti vivi excoquendæ plurimis est usitata.

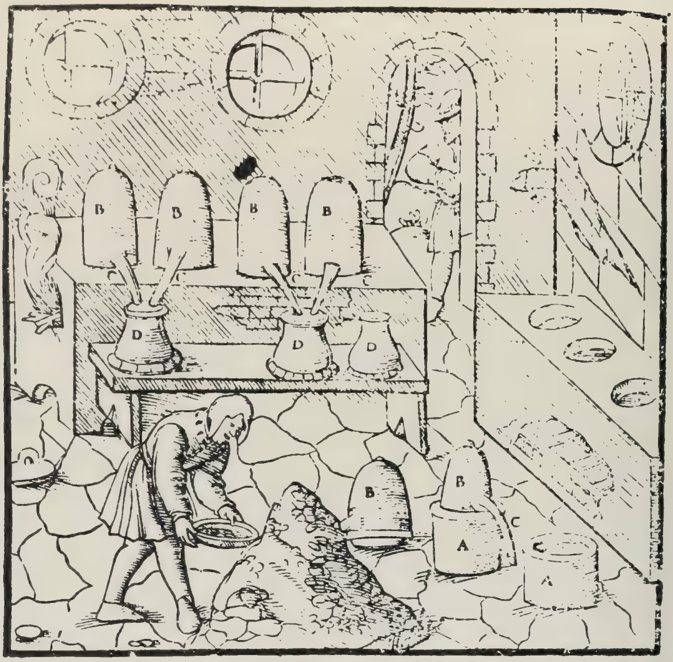
Focus ardens A. *Ligna* B. *Focus non ardens in quo ollæ sunt collocatæ* C. *Saxa* D. *Ollarum ordines* E. *Ollæ superiores* F. *Ollæ inferiores* G.

Simili

Simili modo ſtibii vena, ſi reliquorum metallorum expers fuerit, excoquitur in ſuperioribus ollis: quæ duplo ſunt majores quàm inferiores. Sed quantæ illæ fuerunt, ex panibus cognoſcitur: quibus non omnibus in locis idem eſt pondus: nam alibi conficiuntur pendentes ſex libras, alibi decem, alibi viginti: cùm excoctor in eo labore operam conſumpſerit, ignem aqua reſtinguit: opercula de ollis removet: circum & ſuper eas terram, cum cinere permiſtam, conjicit: panes, ubi refrigerati fuerint, ex ollis eximit. Altera verò venę argenti vivi excoquendę ratio hæc eſt. Ollę ventroſæ in ſuperiorem fornacis quadrangulæ partem patentem impoſitæ, vena comminuta complentur, atq; operculis, quibus ſingulis ejus tintinabuli, quod vulgus campanam nominat, figura eſt ac naris oblonga, teguntur & oblinuntur: ſingula vaſa fictilia, quæ parva ſunt, & in cucurbitæ figuram formata, binas nares recipiunt, itemq; oblinuntur: mox aridis lignis in inferiore fornacis parte collocatis, & accenſis vena coquitur, donec omne argentum vivum in operculum, quod ſuperioris ollæ loco eſt, feratur: id deinde ex naribus defluens, vaſa fictilia cucurbitina recipiunt.

Ollæ A. *Opercula* B. *Naris* C. *Vaſa fictilia cucurbitina* D.

Alia



Alii conclave concameratum extruunt: cujus ſolum pavimentatum faciunt medium verſus concavum, & in muro ejuſdem conclavis craſſo fornaces, quarum ora, per quæ in eas ligna imponantur, exteriore ipſius muri parte ſunt: fornacibus ollas ſuperponunt, & eas vena comminuta complent: circa verò ollas ſic fornaces undiq; lateribus luto conglutinatis claudunt, ut nullus fumus eluctari poſsit: ſed eum totum cujuſq; fornacis os emittat. Deinde inter teſtudinem & pavimentum collocant arbores virides: tum oſtium claudunt, & feneſtellas ſpecularibus obducunt, atq; ſic undiq; muſco & limo obturant, ut conclave nullum argentum vivum exhalare poſsit: poſtea lignis accenſis venam coquunt: quæ tandem exudat argentum vivum: quod caloris impatiens, frigoris amans in arborum folia, quibus refrigeratoria vis eſt, fertur. Excoctor, cùm opus perfecit, ignem reſtinguit, & omnibus refrigeratis oſtium & feneſtellas recludit, atq; colligit argentum: quod, quia grave, magnam partem ſua ſponte ex arboribus decidit: & in concavam ſoli partem confluit: attamen ſi totum non deciderit arboribus commotis decidet.

Conclave A. *Oſtium* B. *Feneſtellæ* C. *Ora fornacum* D. *Fornax qualis in conclavi* E. *Ollæ* F.

Quarta

Quarta ratio venæ argenti vivi excoquendæ ita ſe habet. Olla major ſuper tripodem ſtatuta, completur vena comminuta: cui ſuperfunditur arena vel cinis duos digitos craſſus, & tunditur: mox hujus ollæ ori alterius ollæ minoris os imponitur, & luto obturatur, ne ſpiritum emittat: vena igni cocta exhalat argentum vivum: quod per arenam vel cinerem penetrans, fertur in ollam ſuperiorem: ubi in guttas concreſcens, recidit in arenam vel cinerem: quo lavato, argentum vivum colligitur.

Olla major A. *Minor* B. *Tripus* C. *Vas in quo lavatur arena* D.

Quinta

Quinta ratio eſt quartæ non multum diſsimilis: etenim in locum ollarum ollę, ſive vaſa item fictilia reponuntur: quorum fundum eſt anguſtum, os amplum: ea ferè complentur vena comminuta: cui ſimiliter ſuperfunditur cinis duos digitos craſſus & tunditur. Vaſa verò teguntur operculis digitum craſsis, & interius ſpuma argenti liquata obductis: quibus lapis gravis ſuperponitur: vaſa in fornace collocantur: in quibus vena cocta ſimili modo exhalat argentum vivum: quod fugiens calorem fertur in operculum: ubi congelatum recidit in cinerem: quo item lavato argentum vivum colligitur.

Ollæ A. *Opercula* B. *Lapides* C. *Fornax* D.

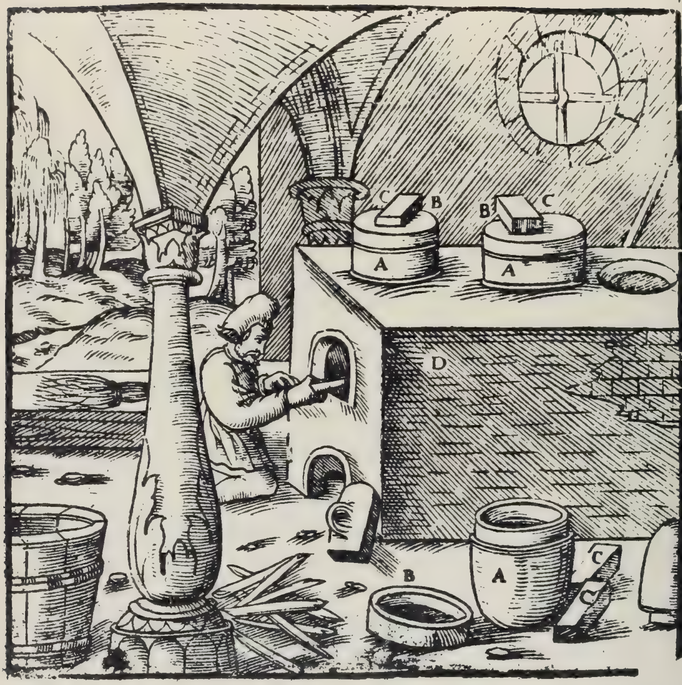
His

quicksilver is reduced in double or single pots. If in double pots, then the upper one is of a shape not very dissimilar to the glass ampullas used by doctors, but they taper downward toward the bottom, and the lower ones are little pots similar to those in which men and women make cheese, but both are larger than these; it is necessary to sink the lower pots up to the rims in earth, sand, or ashes. The ore, broken up into small pieces is put into the upper pots; these having been entirely closed up with moss, are placed upside down in the openings of the lower pots, where they are joined with lute, lest the quicksilver which takes refuge in them should be exhaled. There are some who, after the pots have been buried, do not fear to leave them uncemented, and who boast that they are able to produce no less weight of quicksilver than those who do cement them, but nevertheless cementing with lute is the greatest protection against exhalation. In this manner seven hundred pairs of pots are set together in the ground or on a hearth. They must be surrounded on all sides with a mixture consisting of crushed earth and charcoal, in such a way that the upper pots protrude to a height of a palm above it. On both sides of the hearth rocks are first laid, and upon them poles, across which the workmen place other poles transversely; these poles do not touch the pots, nevertheless the fire heats the quicksilver, which fleeing from the heat is forced to run down through the moss into the lower pots. If the ore is being reduced in the upper pots, it flees from them, wherever there is an exit, into the lower pots, but if the ore on the contrary is put in the lower pots the quicksilver rises into the upper pot or into the operculum, which, together with the gourd-shaped vessels, are cemented to the upper pots.

The pots, lest they should become defective, are moulded from the best potters' clay, for if there are defects the quicksilver flies out in the fumes. If the fumes give out a very sweet odour it indicates that the quicksilver is being lost, and since this loosens the teeth, the smelters and others standing by, warned of the evil, turn their backs to the wind, which drives the fumes in the opposite direction; for this reason, the building should be open around the front and the sides, and exposed to the wind. If these pots are made of cast copper they last a long time in the fire. This process for reducing the ores of quicksilver is used by most people. . . . .

Other methods for reducing quicksilver are given below. Big-bellied pots, having been placed in the upper rectangular open part of a furnace, are filled with the crushed ore. Each of these pots is covered with a lid with a long nozzle—commonly called a *campana*—in the shape of a bell, and they are cemented. Each of the small earthenware vessels shaped like a gourd receives two of these nozzles, and these are likewise cemented. Dried wood having been placed in the lower part of the furnace and kindled, the ore is heated until all the quicksilver has risen into the operculum which is over the pot; it then flows from the nozzle and is caught in the earthenware gourd-shaped vessel.

Others build a hollow vaulted chamber, of which the paved floor is made concave toward the centre. Inside the thick walls of the chamber are the furnaces. The doors through which the wood is put are in the outer part of the same wall. They place the pots in the furnaces and fill them with crushed ore, then they cement the pots and the furnaces on all sides with lute, so that none of the vapour may escape from them, and there is no entrance to the furnace except through



His quinq; rationibus argentum vivum confici poteſt: quarum nulla ſpernenda & repudianda eſt: veruntamen, ſi fodina magnam venæ copiam ſuppeditat, prima eſt expeditiſsima & utiliſsima: quod multa vena ſimul ſine magno impendio excoqui poſsit.

CAPTIONS TO ILLUSTRATIONS

A—Hearth. B—Poles. C—Hearth without fire in which pots are placed. D—Rocks. E—Rows of pots. F—Upper pots. G—Lower pots.

A—Pots. B—Opercula. C—Nozzles. D—Gourd-shaped earthenware vessels.

A—Enclosed chamber. B—Door. C—Little windows. D—Mouths through the walls. E—Furnace in the enclosed chamber. F—Pots.

A—Larger pot. B—Smaller. C—Tripod. D—Tub in which the sand is washed.

A—Pots. B—Lids. C—Stones. D—Furnace.

their mouths. Between the dome and the paved floor they arrange green trees, then they close the door and the little windows, and cover them on all sides with moss and lute, so that none of the quicksilver can exhale from the chamber. After the wood has been kindled the ore is heated, and exudes the quicksilver; whereupon, impatient with the heat, and liking the cold, it escapes to the leaves of the trees, which have a cooling power. When the operation is completed the smelter extinguishes the fire, and when all gets cool he opens the doors and the windows, and collects the quicksilver, most of which, being heavy, falls of its own accord from the trees, and flows into the concave part of the floor; if all should not have fallen from the trees, they are shaken to make it fall.

The following is the fourth method of reducing ores of quicksilver. A larger pot standing on a tripod is filled with crushed ore, and over the ore is put sand or ashes to a thickness of two digits, and tamped; then in the mouth of this pot is inserted the mouth of another smaller pot and cemented with lute, lest the vapours are emitted. The ore heated by the fire exhales the quicksilver, which, penetrating through the sand or the ashes, takes refuge in the upper pot, where condensing into drops it falls back into the sand or the ashes, from which the quicksilver is washed and collected.

The fifth method is not unlike the fourth. In the place of these pots are set other pots, likewise of earthenware, having a narrow bottom and a wide mouth. These are nearly filled with crushed ore, which is likewise covered with ashes to a depth of two digits and tamped in. The pots are covered with lids a digit thick, and they are smeared over on the inside with liquid litharge, and on the lid are placed heavy stones. The pots are set on the furnace, and the ore is heated and similarly exhales quicksilver, which fleeing from the heat takes refuge in the lid; on congealing there, it falls back into the ashes, from which, when washed, the quicksilver is collected.

By these five methods quicksilver may be made, and of these not one is to be despised or repudiated; nevertheless, if the mine supplies a great abundance of ore, the first is the most expeditious and practical, because a large quantity of ore can be reduced at the same time without great expense.

GEORGII AGRICOLAE

DE RE METALLICA LIBRI XII. QVIbus Officia, Instrumenta, Machinæ, ac omnia deniq; ad Metallicam spectantia, non modo luculentissimè describuntur, sed & per effigies, suis locis insertas, adiunctis Latinis, Germanicisq; appellationibus ita ob oculos ponuntur, ut clarius tradi non possint.

EIVSDEM

DE ANIMANTIBVS SVBTERRANEIS Liber, ab Autore recognitus: cum Indicibus diuersis, quicquid in opere tractatum est, pulchrè demonstrantibus.

BASILEAE M. D. LVI.

Cum Priuilegio Imperatoris in annos V.
& Galliarum Regis ad Sexennium.

Aula subterranea
alias
Probier Buch
Herrn
Lazari Erckers
Joh David Zunners im Jahr

AULA SUBTERRANEA
DOMINA DOMINANTIUM
SUBDITA SUBDITORUM.

Das ist:

Unterirdische Hofhaltung/

Ohne welche weder die Herzen regieren/ noch die Unterthanen gehorchen können.

Oder

Gründliche Beschreibung der jenigen Sachen/

so in der Tieffe der Erden wachsen/ als aller Ertzen der Königlichen und gemeinen Metallen/ auch fürnehmster Mineralien/ durch welche nächst Gott/ alle Künste/ Ubungen und Stände der Welt gehandhabet und erhalten werden/ da dann fürnemlich hierinn gelehret wird/ wie sothanige Ertz- und Bergwercksarten/ jede insonderheit ihrer Natur und Eigenschaffe gemäß/ auff alle Metalla probirt/ und im kleinen Feuer versucht werden/ nebst Erklärung einiger fürnehmer nützlichen Schmeltzwerck im grossen Feuer/ Item Ertz scheiden/ bochen/ waschen und rösten/ auch Scheidung Goldes/ Silbers und anderer Metallen/ ingleichem Kupffer seigern/ Messing brennen/ Salpeter sieden/ destillation der Scheidwasser/ und ihrem Brauch/ auch zu nutzmachung anderer mineralischen Berg- und Saltzarten.

Vormals durch den Weltberühmten und gantz Teutschland zierenden

Herrn Lazarum Ercker/

Weiland der Römischen Käyserl. Majest. Obristen Bergmeister auffs treulichste beschrieben.

Anitzo aber/ wegen Abgang der Exemplarien auffs neue mit vielen nützlichen und nohtwendigen Stücken und Secreten/ so entweder Herr Ercker übergangen/ oder nach der Zeit inventirt worden/ und andern Notis über S. Erckers Text mercklich vermehret/ zusambt angehängter Außlegung der Terminorum und Redarten der Bergleute/ Probirer/ Wardeinen und Müntzmeister/ deren sie sich was ihre Profession belangt/ zu bedienen pflegen.

Ein sehr nutzlich und nöhtig Werck vor die Herren der Bergwercke/ Berg-Rähte/ Ertz- und Artzneykündiger/ Probir-Discipeln/ Laboranten/ und alle die mit Metallen und Mineralien umbgehen müssen oder wollen.

Mit möglichstem Fleiß gestellet und außgefertiget/ durch einige hochverständige Bergwercks-Erfahrne und Liebhabere/

Franckfurt/
In Verlegung Johann David Zunners/ Buchhändlers
Gedruckt bey Paulus Hummen Sel. Wittib.
Im Jahr/ M. DC. LXXII.

FLETA MINOR.

THE

LAWS

OF

ART and NATURE,

IN

Knowing, Judging, Aſſaying, Fining, Refining and Inlarging the BODIES of confin'd

METALS.

In Two Parts.

The *Firſt* contains *ASSAYS* of *Lazarus Erckern*, Chief *Prover* (or *Aſſay-Maſter General* of the Empire of *Germany*) in V. BOOKS: originally written by him in the *Teutonick* Language, and now tranſlated into *Engliſh*.

The *Second* contains *ESSAYS* on *Metallick Words*, Alphabetically compoſed, as a DICTIONARY.

By Sir *John Pettus*, of *Suffolk*, K[t]. Of the *Society* for the *MINES ROYAL*.

Illuſtrated with 44 *Sculptures*.

Mal. 3.3. *Numb.* 31.31.
Jehovah Chimiſta Supremus.
Carolus D. G. Secundus.

LONDON,
Printed, for the Author, by *Thomas Dawks*, his Majeſty's *Britiſh* Printer, at the Weſt-end of *Thames*-ſtreet. 1683.

nen Unterſcheid an den ſchwern/ in gleicher Gröſz / gleich wie vom Kupffer gemeldet/ſonſt würd die Prob nicht zu treffen.

Ertz auff Spieſzglaſz zu probiren.

DAs Spieſzglaſz iſt ein ſchönes ſchweres Ertz / faſt einem Bley-Glantz gleich / doch ſpiſſig / welches in Teutſchlandt / und im Königreich Böheimb / in ziemlicher groſſer Anzahl gefunden wird/ wiewol eins reicher und beſſer dann das ander / dieweil man dann ſolches zu etlichen nohtwendigen Sachen haben muſz/will ich/ wie daſſelb zu probiren ſey/allhie auch melden/ und geſchicht am beſten alſo/ nimb deſz Ertzes/als die Haſelnüſz groſz gepucht/2. oder 3. Pfund/ thus in einen Topff/ der unten ein Loch hab / und mit einer Stürtzen bedeckt ſey/ſetz den auff einen andern Topff / verſtreiche die Fugen/ daſz ſie nicht von einander fallen / ſetz ſie zwiſchen Ziegelſtein ins Feuer / der Geſtalt/ daſz der untere das Feuer nicht ſehr berühre / ſondern kühl / und nur der ober in der Glut ſtehe/den man dann wol erglühen ſoll laſſen/ ſo fleuſt das Ertz gar leichtlich / und das Spieſzglaſz davon / durchs Loch in untern Topff/dann laſz es erkalten/ und nimb das Spieſzglaſz herauſz/ ſo ſiheſtu wie viel die eingeſetzten Pfund Ertz/ Spieſzglaſz gegeben haben/ darnach du dich dann wirſt zurichten wiſſen.

Nota.

Spieſzglaſz-Ertz auff Silber zu probiren.

PUche das Ertz ſo klein wie Hanff-Körner/wiege darvon 1. Centner ab / darzu thue Eiſenfeill 16. Centner/ menge es untereinander/röſte es gar gelinde/wie man ein Bley-Ertz röſtet/dann es will ſich ſo roh nicht ins Bley trencken laſſen / und muſz man dieſem Ertz im röſten deſzwegen Eiſenfeill zuſetzen / dieweil der antimonialiſche Schweffel im röſten etwas zu verzehren haben will/anderſt greifft er das Metall an / und würde den Halt vergeringern/ wanns wol geröſtet/ das der Schweffel aller darvon iſt / ſo ſiede es mit 8. Centner Bley an / laſz hernach auff der Cappelle abgehen.

Vom Queckſilber.

DAs Queckſilber-Ertz / iſt ein ſchön roht und braun Ertz / gleich einem rohtgüldigen Ertz / eins Theils gediegen / eins Theils ins Gebirg eingeſprengt. Dieſes Ertz zu probiren/kan nicht in einem offenen Feuer/gleichwie man mit anderm Ertz zu thun pflegt/ geſchehen/oder herauſz geſchmeltzt / ſondern gleich einem Spiritu / in einer ſtarcken Diſtillation davon getrieben werden / derhalben dann auch ſein Metall im Feuer gleich einem Spiritu flüchtig iſt. Queckſilber Ertz.

Bb ij Wie

Beat two or three pounds of the *Oar* fmall, put it in a pot vvith a hole at bottom, cover it, and fet it on another pot, *Lute* the joynings, and fet them between *Tile-ftones* in the fire, that the lovver part may be cool, and that the fire may not touch it, let the upper part ftand in a glowing heat, fo the *Oar* will flow eafily, and alfo the *Antimony* from it through the hole, then cool it, and take out the *Antimony*, fo you will fee how much *Antimony* thofe pounds of *Oar* will produce, and accordingly you may order your felf. Chap. XVIII XIX.

CHAP. XVIII.

Of Quick-filver.

QUICKSILVER is a fine *red* and *brown* Oar, like *Gold Oar*, partly deft and partly *infperged* in the *Mine*. To prove this Oar it cannot be done in an ordinary fire (as the other Oars are, nor melted out of it) but as a *fpirit* muft be driven off in a ftrong *diftillation*, for its Metal is in the fire *volatile* like a *fpirit*. *Quickfilver Oar.*

CHAP. XIX.

How to prove Quick-filver-Oar *for* Quick-filver.

FOR the accomplifhing whereof, the beft way is to take half a pound of it, or fomewhat lefs, beat it as fmall as half a Nut, and put it into a *Retort* or other well luted *Inftrument*, and drive the *fpirit* into another *Inftrument* laid before it in

Wie man das Queckſilber-Ertz auff Queckſilber probiren ſoll.

DIe beſte Weiß/das Queckſilber-Ertz zu probiren/iſt/ daß man deſſelben ein halb Pfund oder weniger / in einen Retorten/ oder ander Inſtrument wol verlutirt/ klein als die halben Haſelnüß groß zerſtoſſen einſetzt / und den Spiritum in ein ander vorgelegtes Inſtrument ins Waſſer / oder in die feuchte treib / ſo reſolvirt ſich der Dampff oder Spiritus/in der Kält oder Näſſe alsbald in Queckſilber / in mangelung aber der Retorten / kan man ein wolbeſchlagnen Glaßkolben darzu brauchen/ und auff den Kolben einen Helm ſetzen / der ziemlich überhengt / in welchen Waſſer gegoſſen ſey / und die Fugen allenthalben dermaſſen wol verlutirt / daß kein Spiritus herauß gehen mag / alsdann ſetze man die Retorten oder den Kolben in ein Oefenlein/ und Feuer mit Holtz erſtlich ſitſam an / hernach das Feuer geſtärckt / ſo treibt ſich das Queckſilber vom Ertz in die Kält oder Näſſe / doch wann der Recipient in der kühle ſtünde / daß er nicht ſehr warm würd/ wäre es beſſer / dann das Queckſilber liebt die Kält und feuchte / und fleucht die Hitz zum hefftigſten/wann du nun in dem probiren Queckſilber gefunden haſt/ſo wiege es wie viel das eingeſetzte Ertz gegeben hat/darnach du dann ferner dein Rechnung machen kanſt.

Was aber anlanget das Queckſilber-Ertz / im groſſen Werck zu ſchmeltzen/ das geſchicht alſo / man puchet das Ertz Stuflein weiß als die Haſelnüß groß/ und thut ſolches in ſondere darzu gemachte Krüg / und in jeden bey vier Pfund/darnach richt man einen ebenen Herdt zu/von feuchter Kohlenleſch / darein ſetzt man runde Schirben / drey zwerch Finger tieff / viel nacheinander / und ſtürtzt darauff die gefüllten Krüg mit dem Ertz / und dennnets mit dem feuchtem Geſtüb / umb den Schirben und Krüg wol nider / dann macht man ein Holtzfeuer darauff / ſo fleucht das Queckſilber die Hitz/ und ſucht die Kälte / welches man dann alles unten im Schirben findet.

Wie nun ſolche Arbeit im groſſen Werck gehet/das iſt bey uns an vielen Orten in Teutſchland/auff den Queckſilber Bergwercken zu ſehen.

Von Eiſen und Stahlſtein zu erkennen und zu probiren.

DEr Eiſenſtein iſt braun / und zeucht ſich ſeine Farb dahin / das er in gemein faſt einem verroſten Eiſen gleich ſihet / der beſte und gar reiche Eiſenſtein aber / der friſch iſt / deß Farb iſt blawlicht / und vergleichet ſich einem gedignen Eiſen : Etliche Eiſenſtein ſeynd Magnetiſch / die durch ihre Natur das Eiſen ſichtiglich

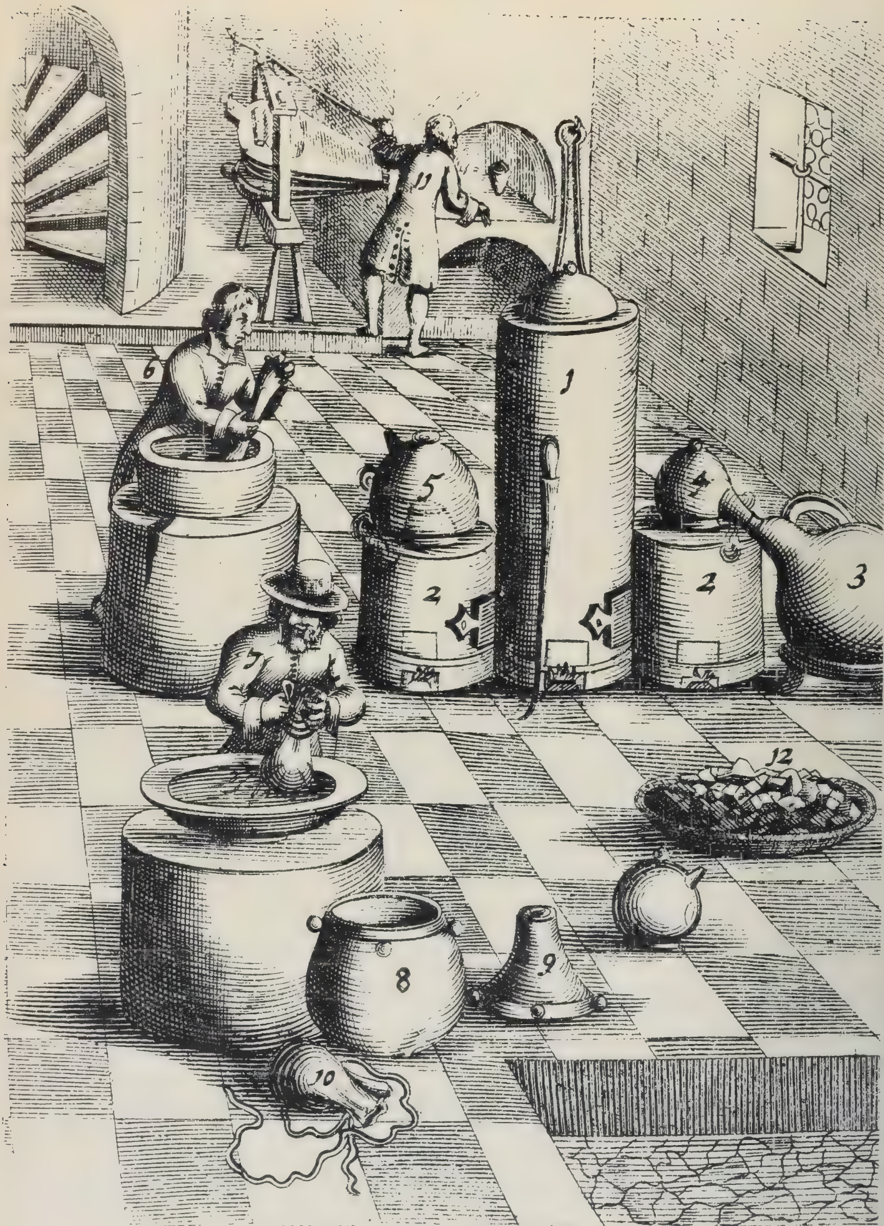
zu

CHAP. XX. in water or other moiſtneſs, thus the vapours or ſpirit will preſently reſolve it ſelf in the coldneſs or wetneſs into *Quickſilver:* But if one hath no *Retorts*, he may uſe a well luted *glaſs Bottle*, and ſet upon the *Bottle* a *Helmet* (which hangs over) in which water is to be put, and the joynings every where well luted, that no *ſpirit* may go out, then ſet the *Retorts* on the *Bottle* in a little Oven, and make firſt a gentle fire with wood, then ſtronger, thus the *Quickſilver* will drive it ſelf from the Oar in the coldneſs or wetneſs, for the *Quickſilver* loves coldneſs and moiſtneſs, and avoideth the heat as its Enemy: ☞ Now when you have found *Quickſilver* in the proof, weigh it, and then you may ſee how much the Oar was which was ſet in, whereby your reckoning may be made accordingly.

But concerning melting of *Quickſilver* in the *great Work*, do thus, beat the *Oar* ſmall as a little *nut*, put it into *Juggs* (made on purpoſe) in each about four pound: then prepare a *flat harth* of moiſtned *Coal-Aſhes*, on which ſet round *Teſts*, three ſquare fingers deep after one another, and turn upon it the *Jugs* fill'd with Oar, ſtop it well with the moiſtned duſt, about the *Teſts* and *Jugs:* then make a wood fire upon it, and the *Quickſilver* will avoid the heat, and ſeek the cold which it finds in the *Teſt* below. *Jugs.*

This Labour in the great Work is to be ſeen in *Germany*, and in many places upon the *Mine-works*.

CHAP.



Instruments to be used to separate quicksilver from gold. 1. *The* Athanor *or* great Furnace. 2. *The* Ovens *on the sides of it*. 3. *The* earthen Receiver *for it*. 4. *The* earthen Helmet *for it*. 5. *The* blind Helmet *with a* Pipe *by which water may be pour'd in*. 6. He *that fitteth the* matter. 7. He *that presseth the* Quicksilver *through a* Leather. 8. The lower part *of the* iron pot *or* Receiver. 9. *The* upper part *of it*. 10. *The* Leather purse *for the* Quicksilver. 11. He *that causeth the* Gold *to melt, by help of the* Bellows. 12. *The* Pieces *of* Metal. Sculpture XVII.

Fleta Minor,

Spagyrick LAWS.

The Second Part.

CONTAINING

ESSAYS

ON

Metallick WORDS:

Alphabetically composed, as a DICTIONARY

TO

Lazarus Erckern.

Illustrated with two *Sculptures*.

By Sir *John Pettus*, of *Suffolk*, Knight.

Scire tuum nihil est;
Nisi te scire, hoc sciet alter.

LONDON,

Printed, for the Author, by *Thomas Dawks*, his Majesty's *British* Printer, at the West-end of *Thames*-street. 1683.

QUICKSILVER, T. *Queckſilver*, L. *Argentum vivum*, *Argentum liquidum*, & *fuſile*, & *Hidrargirum*, or *Argenteum aqueum*, and this by *Chimiſts* is devoted to the Planet *Mercury*, and ſo by them alſo called *Mercury*, for its *Agility*; and therefore the *Heathens* (who worſhip'd it as a *God*, yet) put an humane ſhape on it, with Wings to his Feet.

But our *Metallick Mercury* or *Quickſilver* is of two *Sorts*, viz. *Adulterated*, and *Natural*; as for the *Adulterated*, it is eaſily diſcovered, by putting ſome of it into a *Spoon*, and ſo over fire let it *evaporate*, and if it leaves a *black*, or *duskiſhneſs*, 'tis falſe, but, if *white* or *yellow*, tis good. As for the *Natural* (as I ſaid in the word *Metal*) we have very little or none in our *Mines*, ſo that we do fetch it from our *Neighbours* out of *Hungary*, *Spain* or *America*, &c.

Many have written largely of the Nature of it, and therefore I ſhall only tell you, It is ſeldom found in the Earth with any of the beforenamed *Metals*, but delights it ſelf in the *Cinnabar*, *Vermilion*, or *Minium* Stone (of a Metallick nature, (much us'd by Painters and Dyers) and there naturally is encloſed; and Mr. *Nicolls* (in his deſcription of *America*) tells us, That in the *Vermilion Mines* at *Palcas*, it yields to the King of *Spain* every year 8 or 9000 *Quintals* (which is ſo many 125 *l.* weight of *Quick-ſilver*) and that of later years they refine more *Metals* by *Quick-ſilver* than by Fire, in which operation it hath this peculiar vertue, that it ſeparates and conſumes all of them but *Gold* and *Silver*, and though it will not ly in one Bed with them in the Earth, yet when they are made Play-fellows, or fellow-Labourers (for the uſe of man,) it doth moſt naturally ſympathize with *Gold*, and divides and ſeparates it from all other *Metals*, with which it is at any time intermixt: circling it about

with-

without any other intermixture but it ſelf; but it doth not ſo intimately and perfectly *unite* it ſelf with *Silver*, for it doth not pierce it, but conſumes the courſer Metals from it, if there be any mixture; and though it be the heavieſt of all Metals, yet if any Fire offer to meddle with it, it evaporates it ſelf into the lighteſt ſubſtance, *ſmoak*, to ſome colder Region, (as its refuge or ſhelter,) where it again embodies it ſelf, and becomes as perfect as at firſt, by aſſuming again its *natural colour, white*; and 'tis obſervable, That though it lies in a Bed of pure *Vermilion*, (which gives a glorious *red colour* to all things where-ever 'tis uſed;) and though it is uſed, and in a manner *incorporated* with *Metals* and other things of various *colours* and *natures*, yet this noble *active creature* ſtill retains its *whiteneſs*, *purity* and *efficacy*.

For though by the ſtrength of *Art* (as *Paracelſus* tells us,) it is ſometimes forc't to aſſume a *yellow colour*, (to ſhew its affection to *Gold*) and ſometimes to a *pure red* (to ſhew its native kindneſs to *Cinnabar*, yet theſe are rather *aſſum'd* and *aſſimulated colours* (in reſpect to other *ingredients* and *compoſitions* with it,) than any real change of its own *whiteneſs*, and ſo for its *Medicinal* uſes, it is ſometimes called *Mercurius dulcis*, *Mercurius vitæ*, *Mercurius ſublimatus*, and *Mercurius præcipitatus*, yet in all theſe diſpoſitions of it, it ſtill reverts to it ſelf, (eſpecially by the aſſiſtance of *Fire*, to make it *Volatile*) that it may be the better *fixt* in its original *purity*.

Now theſe obſervations cannot but raiſe my Thoughts, to make them applicable to the great *Miſtery* of *Reſurrection*; wherein I conſider, That as the *Galleniſts* are, or may be confirmed in the verity of it, by St. *Paul*'s Argument to the *Corinthians*, 1 Cor. 15. 35, &c. So the *Chimiſts* may be alſo confirmed in the ſame by their *Chimical practice*, for they ſee that *Mercury* doth by *heat* ſo evaporate, that nothing of it is diſcernible to the eye; yet that *evaporation* being ſtopt in its *career*, by the top of the *Limbeck*, it there fixeth again in its *form*, *colour*, and indeed in all its *qualities*, *properties*, and *perfections*.

[Hh] Now

Now it is an undoubted Principle, both with the *Gallenists* (who follow St. *Paul*,) and the *Chimists* (followers of *Moses*,) That all *Terrestrial Bodies* consist of *Salt*, *Sulphur* and *Mercury*, (which last is the chief) so as our *humane bodies* being of a more *Mercurial* temper than other *bodies*, may *experimentally*, and therefore *rationally* believe, That all the *Atomes* of our bodies being incited to it, by an *internal heat*, do like *Mercury* ascend to some other *limiting Sphere* or *Orb*, and there stays, till GOD (the Worlds great Chimist) thinks fit to dispose of them at the *general Resurrection*, or *particular* (as he thinks fit.)

Now, where this *Sphere* or *Orb* is (which some call *Heaven* and *Paradice*, others *Limbus Patrum*, and *Limbus Infantium*; and others have another place, called *Hell*, and *Limbus inferiorum*, (as it were *Antipodial* to the other:) I shall venture to give my guess, and possibly with as little satisfaction to the World, as others have done in theirs: and that which guids me to mine, is this consideration, That the name for *Quick-silver* is *Mercury*, and that that Name *Mercury* is also fixt to the *Planet* of that Name (next above the Moon, whereby I apprehend that the *Chaldeans* and *Egyptians* (who are said to be the first Authors of the *Astrological Characters* of the 7 *Planets*) did make both the *Planet Mercury*, and the *Metal Mercury* to bear one and the same figure, thus [☿] well knowing more of the *sympathies* and *concurring operations* of the *Celestial* and *Terrestrial Mercuries* than is yet communicated to us; but the *Hebrews* (before them) made seven of their *Letters* to signify the seven *Planets* and seven *Metals*, and thereby the figure of *Mercury* (before it was altered by the *Egyptians*, was in this form [ב] and sometimes thus [ב:] And the *Jewish Rabbins* did hold, that those two *Letters* did contain great Mysteries, (not yet also unfolded to us,) and therefore I hope it is no offence to conceive, That the *Sphere* of *Mercury* is the *Paradice* or *Receptacle* of all the *Mercurial spirituous Forms*, of which our bodies do consist, and when they are *evaporated* from

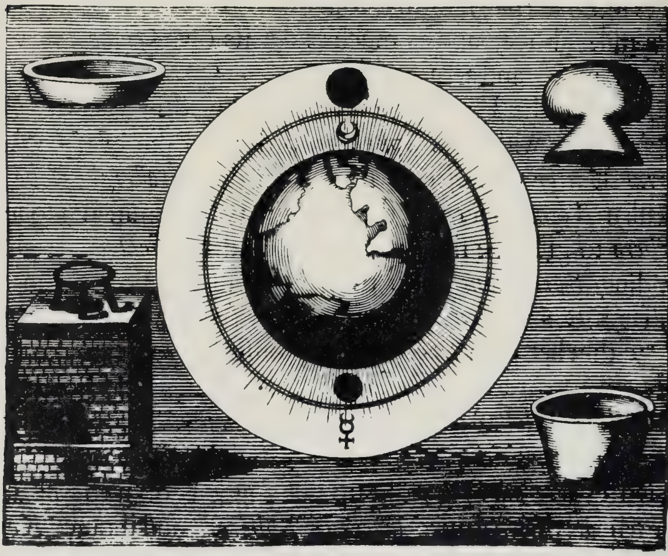
from hence they (by *an invisible ascention*) are *received* and *remain* in that *Paradice* or *repository*, so that the *Globe* of earth being 21600 *German* Miles in circumference(accounting 6400 foot to a *German* mile) and the *Diameter* 7200 Miles, and the *Planet Mercury* in the lower part of its *Sphere* (next the Moon, being 10255773 *German* Miles, and the upper part of that *Sphere* next to *Venus*, being 22855511 *German* miles, then the space of the *Sphere* of *Mercury* (considered Diametrically) between the lower part of the *Sphere* of *Venus*, and the upper part of the *Sphere* of *Luna* is 11599738 *German miles*, which great space may easily contain all the *Mercurial forms* which can possibly arise from the content in the small circumference of the *Terrestrial Globe*, and allow also sufficient room for the body of that *Planet*, (being as 'tis said, but 442 miles in *Diameter*,) so that it hath a space of 62999698 *German* miles above, and as much under its own *Globe*, in which it may move and actuate.

And, as the Planet *Mercury* is imployed in its own Circular Motion, within its *Sphere* to order and put every *Mercurial Matter* that *ascends* to it from the *terrestrial Globe* into peculiar *Repositories*; so the *Moon* may be admitted also in her *Sphere* to give the first *rarification*, and *purification*, to the ascending *Spirituous forms* to make them the more fit in their Passages *to Mercuries Reception* of them, and retain the *refuse* within her own *Sphere*, which consists of a space also (*viz.* between the *Spere* of *Mercury*, and the outward Circle of the *Terrestrial Globe*) of 10234173 *German miles*, for the *Planets* themselves, *viz.* of *Mercury* and the *Moon* (as I have shewn of *Mercury*) do take up but a little Room to *rowl* about in each of their proper *spaces* or *Spheres*, and though *Kepler*, and others of late do not agree in their Computation about the *dimentions* of these two (and the other *Spheres*) yet these which I have set down(being generally so computed) may well serve as an instance, that so great *spaces* were made for some such uses as I have exprest: so that by the active *Operations* of the Bodies

Bodies of theſe two *Planets* (*Luna* being but as a Servant or *vehicular* to *Mercury*) the *Mercurius Dulcis* and *Mercurius Vitæ* of all *humane Bodies* may be ſublimated into that *celeſtial Paradice*, and the *Caput mortuum* or *Mercurius præcipitatus* thrown down into a *Limbus*, either in the ſpace of the *Moon* (at preſent) or to the *Abyſs* of the *ſpace* of the *Earth*, when it ſhall (by the laſt *conflagration*) be *evaporated* or *annihilated* into a kind of *Vacuity* for that purpoſe.

But having ſpoken ſomething more of my Conjecture in my *Volatiles* on *Adam* and *Eve* (under the Diſcourſe of *Reſurrection*) I muſt refer you to it; and ſhall only add this following *Sculpture* for Demonſtration.

Sculpture XLIII.



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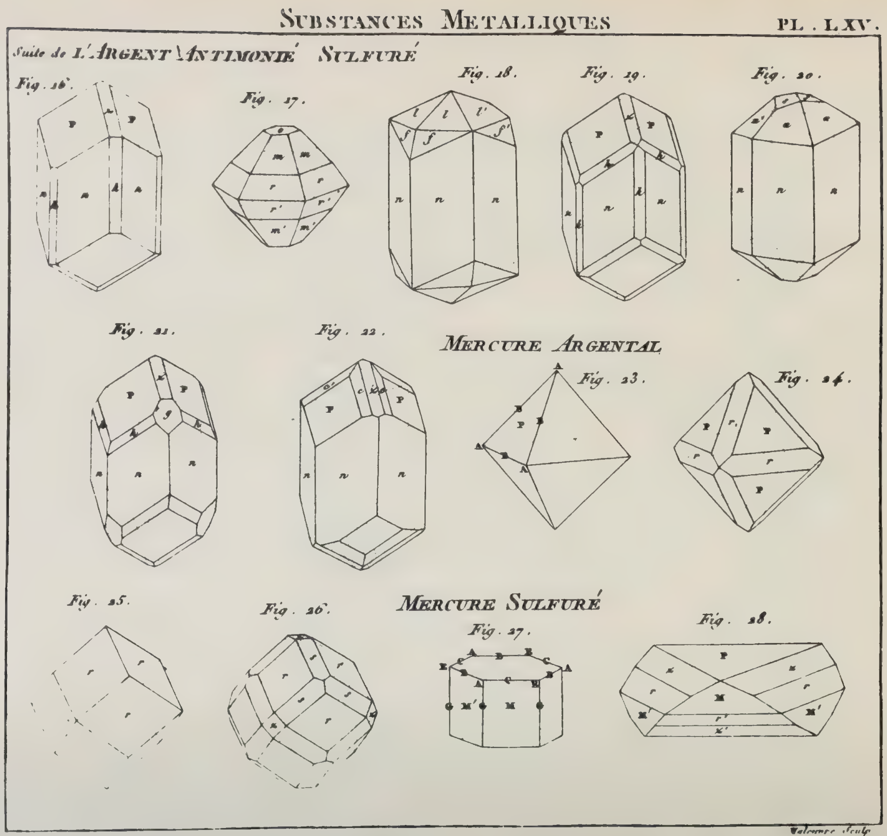
CHAPTER IV

IN WHICH ARE SET FORTH SOME STATEMENTS ON QUICKSILVER DISCOVERIES AND MINING IN CALIFORNIA

BY

PERSONS WHO WITNESSED OR PARTICIPATED IN THESE INTERESTING EVENTS



Drawings of amalgam and cinnabar crystals, from René-Just Haüy's *Traité de minéralogie*, 1801. The chief ore of quicksilver is the red mercuric sulphide (HgS) cinnabar; comparatively little quicksilver is found in the native state.

GOBERNADOR D. BORICA: COMANDANTE F. GOYCOECHEA

On Quicksilver in the Region of Santa Barbara *

1796

Translation by MADELINE C. HERNANDEZ, 1953

1796. = (SIN FECHA)

El Gobr al Comte de Sta Bárbara. Reconocimiento de una veta mineral.

Que queda impuesto del hallarzgo de una veta metálica que parece ser de azogue en Lodos Prietos en la Punta del cerro de la Laguna. Que envie alli á Ortega con 5 hombres para que haga un reconocimiento formal, y quitándo la arena suelta de que le dice estar cubierto el terreno tomen una carga del mineral en lodo ó piedra y lo lleven al Presidio y lo examinen y le avise.

1796. = MARSO 12 = STA BÁRBARA

F. Goycoechea á D. Borica
Descubrimiento de Metal y de azogue

Que el Sargento Jose Maria Ortega, diciendo el haber encontrado una veta de metal y de azogue en el Cerro dela Laguna, á la orilla dela playa, pasó el, á reconocer. Que ha de hacer con dicho metal para mas agrado de S.M.?

1796 (NO DATE)

From the Governor to the Comandante of Santa Barbara
Examination of a Mineral Vein

Be advised of the discovery of a mineral vein which seems to be quicksilver, situated in Lodos Prietos at the point of the Laguna Hill. Send Ortega there with five men so that he can make a proper examination, and remove the loose sand with which the ground is said to be covered; take a load of the mineral, be it in the form of mud or rock; have them take it to the Presidio and examine it, and report.

1796, MARCH 12, SANTA BARBARA

F. Goycoechea to D. Borica
Discovery of Metal and of Quicksilver

Sgt. Jose Maria Ortega said he came upon a mineral vein of quicksilver in the Cerro de la Laguna on the ocean shore, and went over to examine it closely. What is your pleasure regarding this mineral?

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* From the *Provincial Records, tom III-IV, 1784-1800,* and *Provincial State Papers, tom XIV, 1796*; the extracts published herein are from manuscripts in the collection of the Bancroft Library, University of California, Berkeley.

QUICKSILVER MINES. W. N. BARTHOLOMEW. From *Pantoscope of California*, by J. Wesley Jones, in the collection of the California Historical Society, San Francisco.

WITNESSES AT THE TRIAL
UNITED STATES VS. ANDRES CASTILLERO

On the Discovery and Early Working of New Almaden Mine *

Deposition of Antonio Suñol
December 12, 1857

Richard Tobin, Interpreter

Question.—Have you been examined heretofore in this cause?

Answer.—I have. My name is Antonio Suñol; my age is 60 years; my residence is San José. . . . .

Ques.—How long have you lived in California?

Ans.—40 or 41 years; all the time at the Pueblo of San José.

Ques.—When did you first hear of this (New Almaden) mine?

Ans.—In the year 1824. . . . . Myself and Chaboya put a mill there on the stream, and tried to get silver out of it; this was in the year 1824.

Ques.—Was it not generally known ever since 1824 that there was a mine there?

Ans.—It was generally known, but it was not known of what kind it was. . . . .

Ques.—Was it known that the Indians resorted to it?

Ans.—The Indians went there to get paint; they had an idea that the place was sacred. They used to drop feathers there or other little offerings, and they used to say the devil was there.

Ques.—Had the place any name? . . . .

Ans.—It was called "*Pulli*" "*Pooyi.*"

Ques.—When did you first know there was quicksilver there?

Ans.—The first time was when we were examining together, Castillero and myself; we put some of the ore on a hot brick, and drops of the quicksilver ran out. This was done at the Mission of Santa Clara.

Ques.—Who was present at this experiment?

Ans.—Castillero and I were there alone. Padre Real was attending to other matters. After the experiment was made, he and others saw the result. It was generally known and spoken of after that. . . . .

Ques.—Who told Castillero that there was a mine there? . . . . .

Ans.—A person called "El Chato Robles."

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* From *In the United States District Court, Northern District of California. The United States vs. Andres Castillero. No. 420. "New Almaden." Transcript of the Record. P. Della Torre, Esq., U.S. Attorney. Edmund Randolph, Esq., of Counsel. Fred'k Billings, Esq. for Claimant. San Francisco: 1859.*, in the collection of the Bancroft Library, University of California, Berkeley, California.

The first verified discovery of quicksilver ore on the North American continent was made at New Almaden in Santa Clara County a few miles south of the town of San Jose, in 1845. The mine was extremely rich; for several years its title was in dispute, and legal battles for its ownership were fought through state and federal courts.

Material quoted herein from the trial records has been chosen to describe New Almaden's early history, rather than to expose the complicated legal tangle in which the mine was involved. An interesting summary of the famous dispute has been made by Leonard Ascher in *Lincoln's Administration and the New Almaden Scandal*, in the Pacific Historical Review for March 1936; a general review of the mine's history has been published as *The New Almaden Quicksilver Mines*, by Edgar H. Bailey, in Division of Mines Bulletin 154.

NEW ALMADEN QUICKSILVER MINE, CALIFORNIA, JANUARY 1852, by William Rich Hutton.
From the collection of The Huntington Library, San Marino, California.

Ques.—Which Robles was it?

Ans.—Teodoro Robles. . . . .

Ques.—What sort of a mine did he tell him it was? . . . . .

Ans.—A silver mine. . . . . I told him about my having worked the mine in 1824. . . . .

Ques.—Did Castillero show you any stones from the mine?

Ans.—He did.

Ques.—What did he say about them?

Ans.—Various things; sometimes he said it was gold, sometimes silver; finally he ascertained it was quicksilver.

Ques.—Do you remember any experiments made with a gun-barrel?

Ans.—I don't know of any with a gun-barrel; there were some with retorts; they were the old fashioned stills to make liquor. . . . .

Deposition of José Noriega
December 12, 1857

E. F. Dunn, Interpreter

What is your name, age and residence?

Ans.—José Noriega; my age 37; I reside in the Pueblo of San José, Santa Clara county. . . . . I was present at the mouth of the mine when possession was given. . . . . There was a well ("poso") in front of the cave; I don't know how deep the well was. The cave was natural. Señor Castillero had a plate there; he had earth in it moistened with water to see what he could find.

Ques.—Did you know at the time you went there what kind of metal was in the mine.

Ans.—Silver and gold.

Ques.—At that time was the mine known or thought to contain any other metals than silver and gold?

Ans.—I believe not; I am not sure. I think it was only supposed to contain silver and gold.

Ques.—How long after this was it before you knew there was quicksilver in the mine?

Ans.—I do not remember. I know it was not a great while. There was an assay in Santa Clara of various things, and quicksilver was discovered.

Ques.—Who made those assays?

Ans.—No one but Andres Castillero made assays that I know of.

Ques.—When Castillero was washing this earth, did he find anything?

Ans.—Nothing but the earth very much colored—red. . . . .

Ques.—Please to state all that was said and done at the mouth of the mine on the occasion. . . . .

Ans.—We arrived there; we remained a little while; I was laying under a tree at the mouth of the mine; they were speaking about the manner of taking the possession. They arranged that the possession should be taken a certain number of thousand varas in each direction from the mouth of the mine. The Alcalde said—you take this number of varas in each direction. After that we mounted our horses and went home.

Ques.—Who assisted Castillero in the examination of the cave and in washing the earth?

Ans.—Castillero did it alone in a plate.

NEW ALMADEN, JANUARY 4, 1852, by William Rich Hutton. From the collection of The Huntington Library, San Marino, California.

Ques.—Did you see any liquid quicksilver at the mine, at that time?

Ans.—I did not see any.

Examination of James Alexander Forbes

Resumed December 15th, 1857

Ques.—When did you first receive possession of the Mine of New Almaden, and from whom?

Ans.—I received possession of the mine in 1846, from the representative of Castillero.

Ques.—What was his name?

Ans.—José Maria Real, usually known as Padre Real, of the Mission of Santa Clara.

Ques.—Of what did he give you the possession?

Ans.—Of the mine itself, the hacienda, the mining utensils and the ores that had been extracted from the mine. . . . .

Ques.—Describe, if you please, in what condition you found the mine when you took possession. Was it then being wrought; if yea, by how many laborers?

Ans.—The aperture of the mine was an adit or horizontal entrance. The pit of possession or "poso de posesion," was filled with débris of the upper part called "tepetate." The adit was about 20 or 25 feet in length through the rock. The ores were in sight on either side. There was a planila or little plateau on the outside formed of the material taken from the mine. There was one Mayordomo in charge, one blacksmith, and two or three Indians. The Mayor domo and blacksmith resided at the hacienda. One of the Indians remained constantly at the mine and slept in it. They were not at that time actively engaged in extracting the ores.

(The witness desires to add to his former answer, that he received about 2,000 pounds of quicksilver at the time he received possession of the mine.)

Ques. Where did the other Indians stay?

Ans. I don't know. They wandered about there, and down to the Mission of Santa Clara.

Ques. Had you visited the mine at any time during the preceding one, two, three or four months; if yea, had you found laborers engaged in working the mine—if so, at what time and how many?

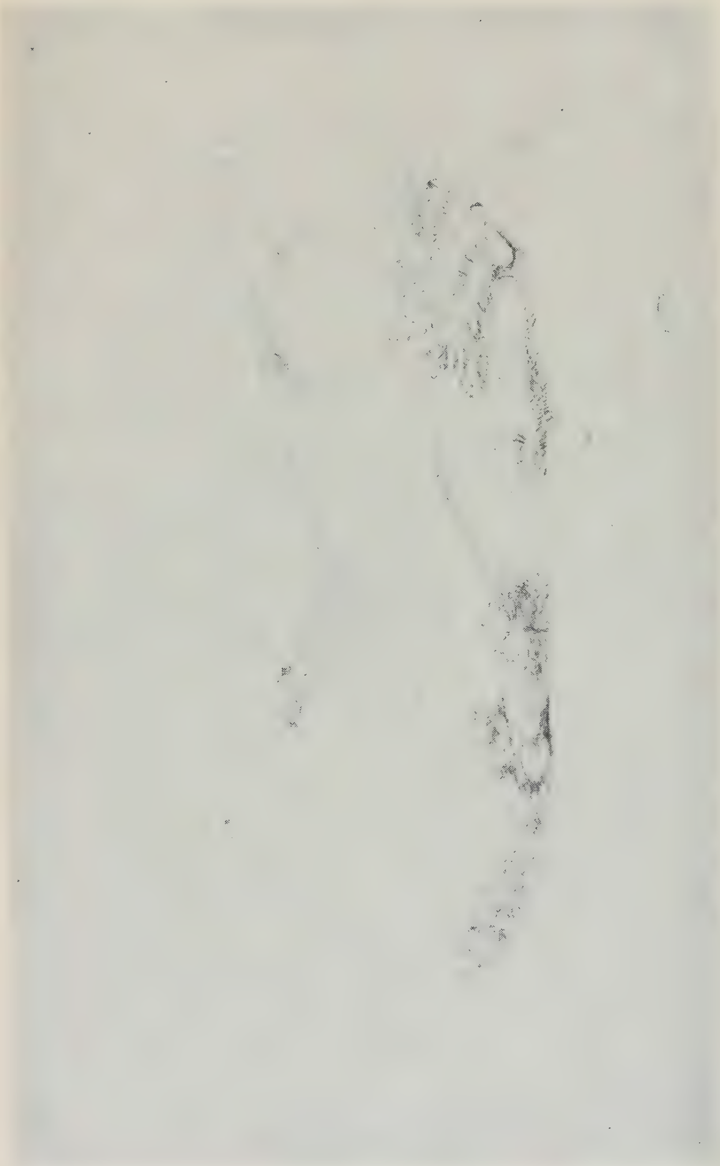
Ans. I had visited the mine about one month previous. The Mayordomo was there; some three or four Indians were at work inside the mine extracting ores. I had not been there before that time. . . . .

Ques. Look at this letter . . . . . and tell me what assays are spoken of in that letter?

Ans. As far as my recollection serves these were assays made at an adit vein by Mr. Alexander Forbes at a place not in the true course of the vein. It was afterwards called "*capricio*."

Ques. Was that assay made by yourself; if so, what was the yield there spoken as "surprising?"

Ans. I made several assays of the ores from New Almaden and San Antonio. They were made with a gun barrel. Probably the surprise expressed was at finding those ores as good as the others, which was not expected. I ought to add that it



Q. S. MINE NUEVO ALMADEN. NEW ALMADEN MINE, JAN. 4TH, 1852, by William Rich Hutton.
From the collection of The Huntington Library, San Marino, California.

was Mr. Forbes' policy to make it appear that there was no large deposit of quicksilver there, as is usual throughout the mining districts of Mexico. I mean that it was his policy at that particular time. The assays were made with a large gun barrel with the muzzle inserted in water.

Ques. What was the largest per centage of quicksilver you remember to have obtained with your gun barrel from the ores of New Almaden?

Ans. As far as my recollection serves, at that time about 26 per cent.

Ques. Did you afterwards obtain a greater yield; if so, when and how much?

Ans. I did. In the progress of the operations rich ores were discovered, of which I have made assays which produced over 40 per cent. It is to be understood that an assay made in the manner I have stated is not subject to the same loss as attends the reduction of ores on a larger scale, owing to the evaporation. . . .

Ques. When you took possession of the mine what constructions had been made for reducing the ores?

Ans. The operations had been conducted on a small scale up to that time. The ores had been confined in two iron pots, the one inverted over the other with an aperture for the escape of the vapor of mercury which was condensed.

Ques. At what time were furnaces for the reduction of ores first erected?

Ans. I erected furnaces at the hacienda in the winter of 1850. They contained iron retorts.

Ques. How many were there?

Ans. There had been some furnaces containing these iron pots erected in 1846. The pots were replaced from time to time as they were decomposed by the action of the sulphur. The brick furnaces at present in use were erected in 1850. The mayordomo erected the furnaces with iron pots. I can't say whether the mayordomo or Castillero erected them. They consisted of two arches, one above the other. The lower received the ashes, the upper the wood. On the upper the pots were placed, the lower received the ore; the upper was inverted over it with a luting at the joint, but with an orifice for the escape and condensation of the vapor. They were built of adobe or sun dried bricks. Mr. Forbes, in 1848, erected similar furnaces but a little larger.

Those I erected in 1850 were similar. They contained each two iron retorts, having doors on the one side and apertures on the other, connected with iron condensers. I erected two of these in 1850.

They were much larger than the previous ones. Each retort was charged with four hundred pounds of ore. . . .

December 17, 1857

Ques.—When you took possession of the mine in 1846, how many entrances had been made into the hill?

Ans.—One.

Ques.—You have mentioned the "poso de posesion," and another entrance, which had gone in about twenty-five feet; was there not also a cave there?

Ans.—I have mentioned but one aperture to the mine, on the left of which was the "poso de posesion." The cavity was originally natural, but that to which I testified yesterday had been excavated by the operators under Castillero, and this I alluded to as about 25 feet long.

New Almaden mine, by William Rich Hutton. From the collection of The Huntington Library, San Marino, California.

Ques.—Was there not a cave there before 1845, where the Indians had been in the habit of resorting?

Ans.—For many years previous to that date it was known that such a cave did exist, and was considered to contain some mineral, the nature of which was not known until discovered by Castillero. The Indians were accustomed to use the ore for paint. I obtained this information from old Indians myself.

Ques.—Then in 1846 there were three apertures, the poso, the adit, and the cave—or was the adit through the cave?

Ans.—There was an artificial enlargement at the mouth of the cave. The poso was visible, but filled up to within a foot or two of the surface with débris, it was very near the mouth. The cave extended beyond the poso; the aperture had been enlarged artificially. The adit had been pushed some twenty-five or thirty feet from the mouth. The poso was on the left near the entrance.

Ques.—How deep was the cave before it was extended as you have described?

Ans.—I am unable to state. I had never been there.

Ques.—Then the depth of twenty-five feet or thereabouts, was the original length of the cave, with the addition of the artificial extension?

Ans.—It was. . . . .

Deposition of Antonio Maria Pico

November 11, 1857

Richard Tobin, Interpreter

Question 1.—Your name, age, and place of residence?

Answer 1.—Antonio Maria Pico; 48; I live at San José in the County of Santa Clara.

Ques. 2.—How long have you lived in California? How long in San José? What public offices, if any, have you held?

Ans. 2.—I was born in California and I have lived here ever since. I have lived in San José since the year 1852. In the year 1835, I was Alcalde at San José. In 1844 and 1845 I was also Alcalde of San José. And in 1849 I was Prefect of San José. I was also a Captain in the Military Organization of California. . . . .

Ques. 1.—When was the first time you ever heard of this mine? . . . .

Ans. 1.—The first I heard were conversations with Pedro and Luis Chaboya, and Robles; on different occasions afterwards Suñol told me that he had assisted them by giving them several things to see if they could ascertain what kind of metal that was, and they never could ascertain what it was.

Ques. 2.—About those times did you never hear anybody else speak of this mine, was it a secret between the Chaboyas, Suñol, and yourself, or was it commonly talked of? . . . .

Ans. 2.—It was commonly talked of.

Ques. 3—How long ago is it since it was commonly talked of? . . . .

Ans. 3.—A great many years since.

Ques. 4.—About how many years, beginning with about what year? . . . .

Ans. 4.—I first heard the mine spoken of in the year 1835; in the year 1845, when Castillero first came to San José, the matter had been forgotten there, it was no longer spoken of because it was not known whether it was a gold or a quicksilver mine or what it was, and Castillero was the first person who knew the metal.

Ques. 5.—And what had Robles to say about it when it was first spoken of? . . . .

Ans. 5.—He said that they had been there at working, breaking stone, but that they were unable to ascertain what kind of metal it was.

Ques. 6.—By what name was this mine known in those times? . . . .

Ans. 6.—It was then known under the name of the mine of the Chaboyas.

Ques. 7.—When was it first known as the mine of Santa Clara? . . . .

Ans. 7.—In Castillero's time.

Ques. 8.—When was it first called New Almaden? . . . .

Ans. 8.—It was first called New Almaden in Castillero's time also. It was called by both names, but that of New Almaden was latterly more generally used than that of Santa Clara Mine.

Ques. 9.—What do you mean by latterly? . . . .

Ans. 9.—I mean to say that when Castillero took possession of the Mine it was publicly known as the New Almaden Mine or the Santa Clara Mine.

Ques. 10.—Do you mean that Castillero gave it the name of New Almaden? . . . .

Ans. 10.—I don't know who gave it that name, but in Castillero's time I have heard it called by that name. . . . .

Ques. 16.—Was it then or was it not Castillero who gave to this Mine the name of Santa Clara? Who gave it that name, and when? . . . .

Ans. 16.—I don't know who gave it this name; it was called so formerly in the time of the Fathers. The Indians used to go there for yellow paint for the Church, but it was a mine that was not worked.

New Almaden mine, by William Rich Hutton. From the collection of The Huntington Library, San Marino, California.

Ques. 17.—What have you heard from the old inhabitants of the Pueblo of San José and the Mission of Santa Clara concerning the first knowledge that civilized people obtained of this Mine, how long had its existence been known, and in what manner was it brought to their knowledge? . . . .

Ans. 17.—I had not heard any one say when the existence of the Mine was first known, nor how it was discovered, nor when.

November 12, 1857

Ques. 18.—Then you have heard no tradition among the old people concerning this Mine? . . . .

Ans. 18.—I heard no tradition amongst the first inhabitants touching this Mine. All that I heard was from the persons whom I have named.

Ques. 19.—Was it only since the year 1835, about which time you remember having heard Robles, the Chaboyas' and Suñol talk about the Mine, that the Indians were accustomed to go there to get yellow paint for the Church? Had it not been the custom of those Indians from the time of the earliest inhabitants? . . . .

Ans. 19.—In the year 1835 it was said in San Jose that the Indians were in the habit of going to the mine for paint, but I do not know whether they went in the time of the earliest inhabitants.

Ques. 20.—For how long a time before 1835 had the Indians been accustomed to go to the mine for paint, according to the report you may have heard among the old inhabitants? . . . .

Ans. 20.—I do not remember how long.

Ques. 21.—Were they accustomed to go there at all before the year 1835, according to the old inhabitants? . . . .

Ans. 21.—I do not remember to have heard how long prior to the year 1835 they had been accustomed to go there. . . . .

Ques. 24.—Did you hear in 1835 that this mine contained quicksilver? . . . .

Ans. 24.—No, I heard nothing of it.

Ques. 25.—What mineral was the mine supposed to contain? . . . .

Ans. 25.—I did not know what it was, I did not hear what the supposition was.

Ques. 26.—Did you hear after 1835 and before the time of Castillero that the mine contained quicksilver. During that interval what metal was it supposed to contain? . . . .

Ans. 26.—During the period mentioned I did not hear that the mine contained quicksilver; during that time there was no supposition as to what the mine contained: it was through Castillero that the contents of the mine were ascertained.

Ques. 27.—Did you not hear Antonio Suñol in the year 1835, or at some time afterward, and before the year 1845, say that the mine contained quicksilver. What did you hear him say that he supposed the mine contained? . . . .

Ans. 27.—I do not remember having heard Suñol say what the mine contained, during the time mentioned, nor what he supposed it contained. . . . .

N. A., FEB. 8, 1852, by William Rich Hutton. From the collection of The Huntington Library, San Marino, California.

November 14, 1857

Ques. 75.—In the first petition [*] of Castillero which you have before you, he says that he had discovered this Mine; why did you receive that petition when you knew it was untrue, because the Chaboyas had occupied it in 1835, and the Indians had long been accustomed to bring paint from it for the Church, as you have before testified? . . . .

Ans. 75.—Castillero was the first who brought to light the metal, the quicksilver. He produced before me the metal as a proof of what he said.

Ques. 76.—Read that petition; does it say anything about quicksilver? What metal does it say the Mine contained? . . . .

Ans. 76.—The petition speaks of gold and silver, but it was known that it contained quicksilver, because I saw it myself.

November 18, 1857

Ques. 77.—If it was known that the Mine contained quicksilver when that first petition was presented to you, why was not quicksilver expressed in the petition? Why was it not mentioned along with gold and silver? Was not quicksilver at that time considered a valuable metal? . . . .

Ans.—I do not know why quicksilver was not mentioned in that petition. It was known at that time that quicksilver was a precious metal.

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[*] AÑO DE 1845.

Espediente del denuncio, posesion y compañia, de la mina de azogue, nombrada "Santa Clara," en la Alta California.

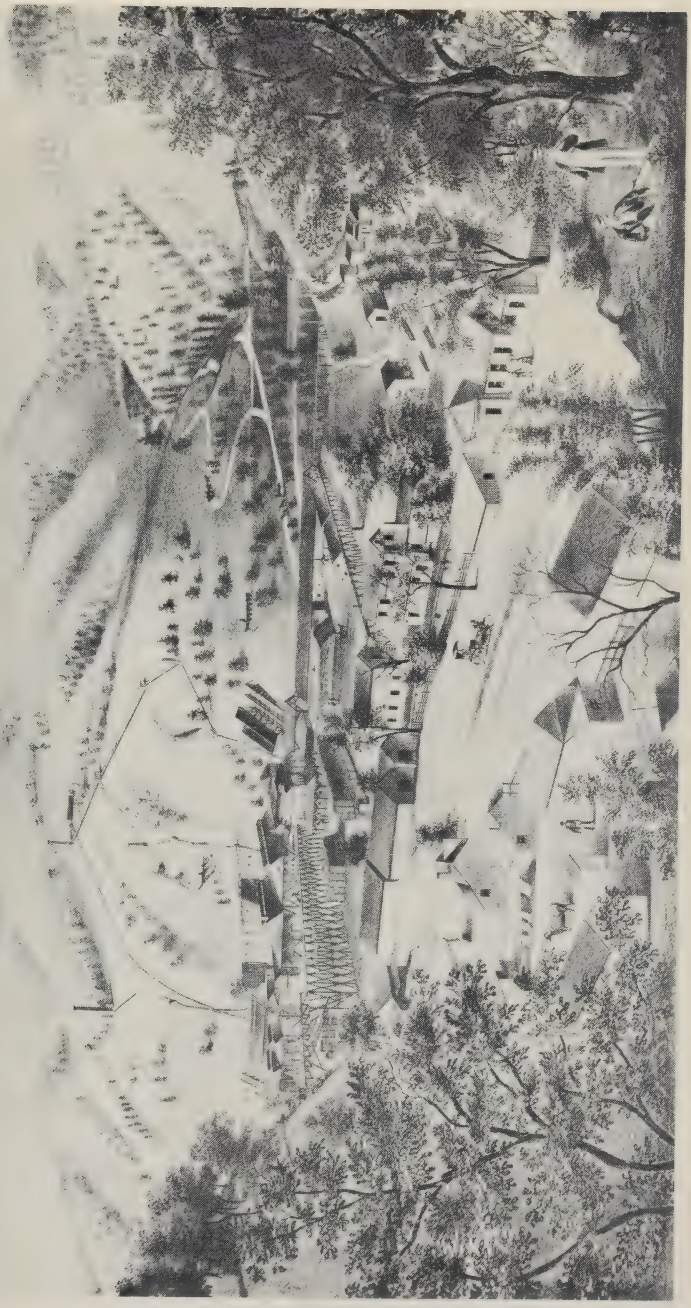
SEÑOR ALCALDE DE 1a NOMINACION:

Andres Castillero, Capitan de Caballeria permanente, y residente hoy en este Departamento ante la notoria justificacion de Vd. hace presente, que habiendo descubierto una veta de plata con ley de oro, en terreno del rancho perteneciente al Sargento retirado de la compañia presidial de San Francisco, José Reyes Berreyesa, y queriendo trabajarla en Compañia suplico á Vd., que arreglado á la ordenanza de mineria, se sirva de fijar rotulones en los parajes publicos de la jurisdiccion para que llegado el tiempo de la posesion jurídica, asegure me derecho, segun las leyes de la materia, á Vd. suplico provea de conformidad, en lo que recibiré merced y justicia: admitiendo este en papel comun por falta del sellado correspondiente. Pueblo de SanJosé Guadalupe, Noviembre veinte y dos de mil ochocientos cuarenta y cinco.

ANDRES CASTILLERO.

(Year, 1845. Expediente of the denouncement, possession, and partnership of the Quicksilver Mine, called "Santa Clara," in Upper California. Señor Alcalde ó lst Nomination. Andres Castillero, Captain of permanent cavalry, and at present resident in this Department, before your notorious justification, makes representation: that having discovered a vein of silver, with a ley of gold, on the land of the rancho pertaining to José Reyes Berreyesa, retired sergeant of the presidial company of San Francisco, and wishing to work it in company, I request that, in conformity with the ordinance on mining, you will be pleased to fix up notices, in public places of the jurisdiction, in order to make sure of my right when the time of the juridical possession may arrive, according to the laws on the matter. I pray you to provide in conformity, in which I will receive favor and justice; admitting this on common paper, there being none of the corresponding stamp. Pueblo of San José Guadalupe, November twenty-second, eighteen hundred and forty-five. Andres Castillero.) From *Before the U.S. Board of Commissioners to Ascertain and settle Private Land Claims in California. No. 366. Claim of Andres Castillero to the Mine and Land of New Almaden,* in the collection of the Bancroft Library, University of California, Berkeley.

Portion of the TOPOGRAPHICAL MAP OF CENTRAL CALIFORNIA, STATE GEOLOGICAL SURVEY OF CALIFORNIA, J. D. WHITNEY, STATE GEOLOGIST, 1873, showing the location of the New Almaden mines, including the Guadalupe and Enriquita (Henriquita).



ALMADEN IN 1876. From Thompson & West's *Atlas*, in the collection of the California State Library, Sacramento

Ques. 78.—If it was known at the date of the first petition that the Mine contained quicksilver, how did it happen that eleven days afterwards Castillero presented a second petition [†] in which he declared that he had made the discovery of quicksilver since the date of his first petition? Before answering this question look at this second petition of Castillero which you now have before you.

Ans. 78.—I do not remember why this was done, it is a very old affair and I cannot remember. . . . .

Ques. 89.—What sort of a possession [was taken of the mine]? Who went with you to the mine? Who were there present? What Surveyor did you have, and what instruments? What measurements did you make, what works did you perform. How many stakes did you drive, where, and by whom were they driven? Tell all that occurred, how long you stayed there, when you returned and to what place? Say also what Mining Professor was there present.

Ans. 89.—Suñol, Noriega, El Padre Real, Castillero, Gutierrez, and I think Fernandez also, went with me to the mine; other persons went, but I do not remember who they were. These same persons arrived at the mouth of the mine, we were there sometime, and I sent for Sergeant Jose Reyes Berryesa to his Rancho. These were there. There were also other persons there, but I do not remember who they were. There was no Surveyor. Castillero had a small pocket compass. I told Castillero that no measurement could be made with a cord because the ground was very uneven; that he might take three thousand varas within the Sierra, (mountains) in every direction; everything that was spoken there was written in a blotter; all that I said to Castillero; this was the only work we performed. I do not remember having driven any stakes; I do not remember whether any were driven or not. We remained a considerable length of time at the mine, I do not know how many hours we were examining everything; we returned to San Jose, where we arrived very late. The only Professor of Mining who was there was Castillero, because he understood it.

[†] Señor Alcalde de 1ª Nominacion del Pueblo de San Jose de Guadalupe:

Andrés Castillero, Capitan permanente de Caballeria, ante la notoria justificacion de Vd. comparezco y digo: ensayando el mineral que con anterioridad denuncié á ese juzgado, he sacado, á mas de plata con ley de oro, Azogue líquido, en presencia de algunos concurentes que podré citar en caso oportuno. Y por convenir asi á mi derecho le he de merecer á Vd. que unido al escrito del denuncio, se archive esta presentacion, no llendo en papel del sello por no haberlo.

A Vd. suplicio provea de conformidad; en lo que recibiré merced y justicia.

Santa Clara, Diciembre 3, de 1845.

Andres Castillero.

(Señor Alcalde of 1st Nomination. I, Andres Castillero, permanent captain of cavalry, before your well known justification, appear and say: that on opening the mine which I previously denounced in this Court, I have taken out, besides silver with a ley of gold, liquid quicksilver, in the presence of several bystanders, whom I may summon on the proper occasion. And, considering it necessary for the security of my right so to do, I have to request of you, that uniting this representation to the denouncement, it may be placed on file, it not going on stamped paper because there is none. I pray you to take measures to this effect, in which I will receive favor and grace. Santa Clara, December 3d, 1845. Andres Castillero.) From *Before the U.S. Board of Commissioners to Ascertain and settle Private Land Claims in California. No. 366. Claim of Andres Castillero to the Mine and Land of New Almaden*, in the collection of the Bancroft Library, University of California, Berkeley.

Ques. 90.—Was the land of which you say you thus gave possession in its form a square or a circle? . . . .

Ans. 90.—I do not know whether it was circular or square, because I made the division in different directions, as I proposed to Castillero, that is to say, that he should take it where it was vacant, or in the mountains, because the Rancheros (owners of the Ranches,) would not have mountains; they wanted plains only. . . .

Deposition of William G. Chard

December 15, 1858

QUESTION 1.—Your name, age, place of residence and occupation?

ANSWER 1.—William G. Chard; I am 58 years of age; I reside in Tehama County, State of California; I am a farmer.

Q. 2.—Do you know the Almaden Mine?

A. 2.—I do.

Q. 3.—When did you first know it?

A. 3.—In 1845.

Q. 4.—Were you ever employed in or about the mine; state when, by whom, and in what capacity?

A. 4.—I have been so employed; it was in 1845; I was employed first by Mr. Castillero and the priest Don José Maria Real. I went up there to open the mine. I forget exactly what time of the year it was. I hardly know whether it was in November or December, 1845; I think it was in one of those months. . . . .

Q. 9.—How long did you remain at the mine after possession was given to Castillero?

A. 9.—I remained there, I think, until August, 1846.

Q. 10.—What did you do there; what was your business?

A. 10.—I was building houses. I built a furnace and smelted the ore, got out some quicksilver, I should judge three or four tuns of quicksilver in the pot—it was one of a whaler's try-pots—we burnt it out under try-pots, that is, we first made a well and put at the bottom of it a trough full of water, then we had part of a copper still which went down into the water in the trough and there were bars of iron laid across the mouth of the well and the ore piled on top of them, made the pile the size of the pot and covered it with the pot turned upside down, we then piled the wood on top of the pot and around the pot, set fire to the wood and in that way we got out from three to four tuns. The top of the copper still was attached and came up to the iron bars over the top of the well and the vapor was forced through the pipe into the water by heat.

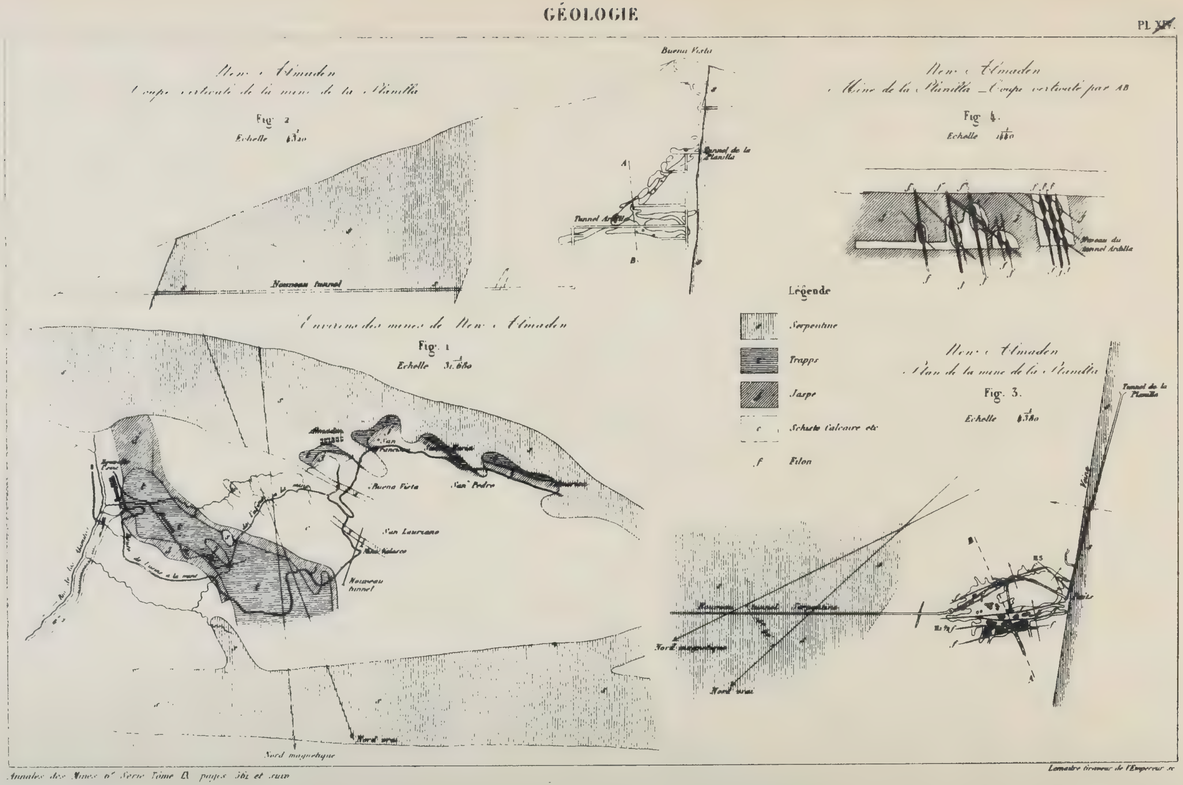
Q. 11.—How many men were engaged at the mine and reducing establishment while you were there; I mean, what would be about the average number of laborers there about that time?

A. 11.—To the best of my recollection, ten or twelve, Indians, principally, only one white man besides myself; I do not recollect his name; they used to call him Old Billy, he was a blacksmith.

Q. 12.—Who was Superintendent of the mine when you had charge of it?

A. 12.—I was Superintendent.

Q. 13.—Under whose direction did you work?



GEOLOGIE. Fig. 1. Environs des mines de New Almaden. Fig. 2. New Almaden. Coupe verticale de la mine de la Planilla. Fig. 3. New Almaden, Plan de la mine de la Planilla. Fig. 4. New Almaden. Mine de la Planilla.—Coupe verticale par AB. Pl. XIV. Annales des mines. 6e Série. Tome IX, pages 561 et suiv. Lemaitre Graveur de l'Empereur sc. From Coignet, M., *Rapport sur les mines de New-Almaden (California)* . . . *Paris, 1866,* in the collection of the California State Library, Sacramento

A. 13.—First under Castillero's, and after he went away, under Padre Real's; under his direction I built the furnace.

Q. 14.—Describe that furnace?

A. 14.—It was made out of that adobe, about eight feet in diameter measured on the outside, about ten feet high and circular; it had two chambers one over the other, the top of the under one was full of holes so that the fire could draw up into the other; the upper we charged with ore from the top; there were six or eight pipes from this upper oven that conducted the vapor into water; the hole at the top of the upper chamber was closed with an iron door and cemented.

Q. 15.—How did the furnace succeed?

A. 15.—It did not succeed very well, it got hot and burst.

Q. 16.—Did you make any quicksilver from it?

A. 16.—We made some, I do not recollect how much, we never charged it but once.

Q. 17.—Who attended the furnace, and was anybody injured by the vapors?

A. 17.—It was attended by no one but myself and the Indians. I got badly hurt with it, salivated, and it came very near killing me. . . . .

December 16, 1858

Q. 47.—Had Andres Castillero left the country before you built the furnace with the two chambers. . . . ?

A. 47.—I think he had.

Q. 48.—Before Andres Castillero left the country was there any furnace at all, or did you get out the quicksilver by making a fire over the iron pot. . . . ?

A. 48.—I think he went away before we smelted the metal under the pot or in the furnace; I am not certain of it; I don't remember of seeing him after trying experiments with gun-barrels, at the mine.

Q. 49.—That quicksilver which you got out and left there in the pot, did you weigh it?

A. 49.—I don't remember.

Q. 50.—Did you ever weigh any quicksilver at that time?

A. 50.—I think I weighed a glass junk-bottle full.

Q. 51.—When you said yesterday that you supposed the quicksilver in the pot might have been three or four tuns, was it merely a guess on your part?

A. 51.—Yes, it might.

Q. 52.—Might it not have been as little as 2,000 1,800 or even 1,500 pounds, for all that you can swear to now?

A. 52.—I do not know; I stated that yesterday. I have no idea, there was about half a kettlefull.

Q. 53.—After your adobe furnace burst, what did you do then?

A. 53.—Pulled it down, gathered all the quicksilver we could get between the adobes.

Q. 54.—Then what?

A. 54.—We continued burning under the pot afterward.

Q. 55.—You carried on this smelting somewhere about where the hacienda is now, did you not?

A. 55.—Somewhere about the same place.

NEW ALMADEN, THE HACIENDA. WATKINS PHOTO. HELIOTYPE PRINTING CO. From J. D. Whitney's *Geological Survey of California . . . 1860 to 1864,* in the collection of the California State Division of Mines, San Francisco.

NEW ALMADEN MINE, THE PLANILLA. WATKINS PHOTO. HELIOTYPE PRINTING CO. From J. D. Whitney's *Geological Survey of California . . . 1860 to 1864,* in the collection of the California State Division of Mines, San Francisco.

Q. 56.—Who had charge at that time of the mine, which was about a mile from the place where you were employed?

A. 56.—A Mexican; I don't recollect his name.

Q. 57.—Had you anything at all to do with the operations inside the mine, during the period to which you refer?

A. 57.—Nothing.

Q. 58.—About how often did you smelt or reduce ore?

A. 58.—About every day under the pots; I think we had two pots sometimes. . . . .

Q. 14.—How was the ore brought from the mine to the reducing establishment?

A. 14.—On mules. . . . .

Q. 18.—Who assisted you in making the well you have spoken of, with the trough at the bottom, and the iron bars over the top of it, and contriving the iron pot furnace?

A. 18.—I think Padre Real was there something like a week; there was myself and Billy, the blacksmith, with the Indians. Padre Real was there when we first commenced making the furnace. Padre Real and Secundino Robles were there when we first started the fire around the pot furnace. Robles sat up with me all night to keep up the fire around the pot. . . . .

Q. 2.—Whilst you were up at the mine and before you went down to the creek, to the reducing place, how did you extract quicksilver?

A. 2.—In gun-barrels. We formed a little furnace in the bank and charged the gun-barrels with ore and put them over the furnace, stopped the touch-hole, the muzzle dipped into water in a pan, or bucket, or something else; there were three or four gun-barrels.

Q. 3.—Did you continue to do this after the possession. . . . ?

A. 3.—I think we were working with the gun-barrels at the time they gave the possession. I think we continued working with the gun-barrels after the possession for a little, but not much. It was a slow process, could not use the gun-barrels after they would get corroded; would get from one-half to one ounce of quicksilver out of each barrel.

Q. 4.—Was that all you got out prior to the possession you have spoken of?

A. 4.—I think that was all we got out except a little gotten out at the Mission in the same way.

Q. 5.—Where did you get the ore from that was used for these experiments?

A. 5.—Got it out of that cave. Don't recollect from what part of the cave; the Indians got it out.

Q. 6.—Was the ore visible in the sides of the cave?

A. 6.—Yes, the cave was red with it.

Q. 7.—Did you not always direct the Indians in taking the ore out?

A. 8.—I did when Castillero was not there; he stopped there when I first went up there.

Q. 9.—Don't you remember whether you adopted a particular plan with the Indians in digging?

A. 9.—After we commenced digging the well, they piled up the ore outside; I think the well was made a little outside the cave. I never was at the mine more

than three or four times after I went down on the creek. I don't recollect whether we made the well before I went down to the creek or afterward. I went prospecting around to see if I could find the ore in any other place.

Q. 10.—Do you recollect when you were experimenting with the gun-barrels, whether you got the ore out of the well or out of the cave?

A. 10.—I think it was out of the cave.

Q. 11.—Did this well open into the cave?

A. 11.—Yes, I think it did. There was only one way of getting into the cave; I won't be positive about it. . . .

Deposition of Peter Davidson
January 22, 1859

QUESTION 1.—Your name, age, place of residence and occupation?

ANSWER 1.—Peter Davidson; I am about 43 years of age; I reside in San José, county of Santa Clara; I am living on my income. . . . . I came to California in 1841. Since 1842 I have been residing in San José and reside there now. I remember to have heard of the discovery of a mine by Castillero. . . . .

Q. 8.—Do you remember to have heard of the possession of this mine having been given to Castillero? . . . .

A. 8.—Yes. . . . .

Q. 11.—Did you ever visit the mine with Castillero? . . . .

A. 11.—I have visited the mine with Castillero and Padre Real; it was before possession was given, about October or November 1845.

Q. 12.—Was any one at the mine when you visited it?

A. 12.—There was a gentleman by the name of Chard, a couple of Mexicans and three or four Indians. I believe Father Real or Castillero, or between the two, they put Chard there as an overseer.

Q. 13.—What was done while you was at the mine?

A. 13.—Old man Robles was there too, besides Chard, the Mexicans and the Indians; old man Robles died about three years ago; we tried to get some quicksilver; they were working with crowbar and picks getting ore out.

Q. 14.—How did you get the quicksilver out?

A. 14.—Took a gun-barrel, run it through a cask which he filled with water—the muzzle running into a basin—put some of the ore inside of the gun-barrel first, put fire around the breech of the barrel; the quicksilver dropped into the basin. . . . .

Deposition of Jacob P. Leese
May 30, 1859

QUESTION 1.—What is your name and place of residence?

ANSWER.—Jacob P. Leese; place of residence, Monterey. . . . .

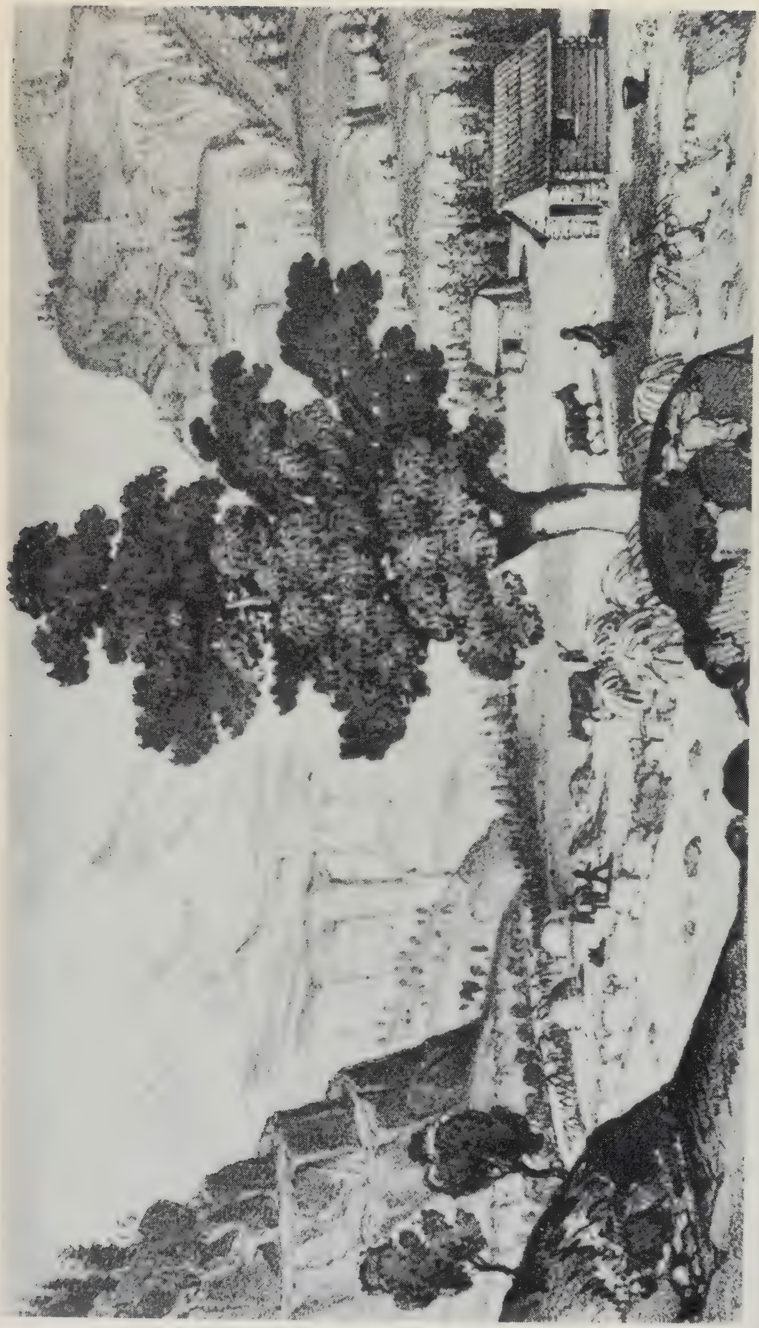
Q. 4.—Do you know anything about the discovery, by Castillero, of metal in the ore taken from the place now called the Almaden Mine? if yea, please state what you remember about it.

A. 4.—About the latter part of November, or first of December, 1845, I went into the mission of Santa Clara to dine with Padre Real of the mission; Mr. Castillero was there. Our general conversation through dinner was about

this mine, and of the experiments which Castillero had been trying, to find out what the mineral was. He made a remark, and said he thought he knew what it was; if it was what he supposed it was, he had made his fortune. We were anxious to know what it was. He got up from the table and ordered the servant to pulverize a portion of this ore; after it was pulverized he ordered the servant to bring in a hollow tile full of lighted coals; he took some of the powdered ore and threw it on the coals; after it got perfectly hot he took a tumbler of water and sprinkled it on the coals with his fingers; he then emptied the tumbler and put it over the coals upside down; then took the tumbler off and went to the light to look at it; then made the remark that it was what he supposed it was, "quicksilver." He showed all who were there the tumbler, and we found that it was frosted with minute globules of the metal, which Castillero collected with his finger and said it was quicksilver. He then said: to-morrow he would test it thoroughly and find out what it was worth, he considered it very rich on account of the weight of the ore, and if it proved as rich as the quicksilver mines in Spain, that the Mexican Government had offered to any one for the discovery of such a mine in the Republic of Mexico, one hundred thousand dollars.

Q. 5.—Was there any experiments made the next day?

A. 5.—I did not remain to see. I went early the next morning to the pueblo of San José. The next following evening, at San José, it was rumored about that this ore produced quicksilver. I don't remember the person, but it was some person explained the process who had seen it; he told me they had succeeded in obtaining a small vial of quicksilver by using a gun-barrel. I left the pueblo and went by way of Contra Costa to my home in Sonoma, and a few days afterwards Mr. Castillero sent General Vallejo, at Sonoma, a vial of quicksilver, with a letter informing him of the discovery. Castillero had been previously, that is sometime in the month of November, over in Sonoma, and had conversed with General Vallejo about some mineral, the nature of which he had not then ascertained. . . . .



QUICKSILVER MINE—NEAR SANTA CLARA. SKETCHED BY J. W. REVERE, U.S.N.
LITH. OF WM. ENDICOTT & CO., N. Y.

JOSEPH WARREN REVERE

On the Working of New Almaden †

CA. 1846

Passing through the mission of Santa Clara, we arrived at San José about dark. Having rested a day, and looked around the village of San José, which is hardly worth describing, we visited several ranchos and also the famous quicksilver mine in the vicinity.

The depôt is situated in a secluded and romantic glen, about three leagues from San José. The mine itself [New Almaden] is on the top of a high mountain, and the ore is brought down on mules, the path being very precipitous. The ore is red cinnabar, and the quality is extremely rich, yielding from thirty to forty per cent., even by the rude and inadequate process which is adopted by the miners, although all the quicksilver might be easily disengaged from the ore. The process is as follows: Large whalers' try-pots are inverted over a heap of ore laid on an iron grate, beneath which a stream of water is made to pass. The edges of the pots being luted to the hearth in which the grate is fixed, a fire is made on the outside of the pots, and the dense mercurial vapors, evolved from the ore as it bakes, finding no vent save through the interstices of the grate, is condensed, and falls, in its metallic form of quicksilver, to the bottom of the little well or stream beneath. The vein is very rich, and the whole surrounding hills appear, from their reddish color, as if they contained inexhaustible quantities of ore. The cavity in the mountain, of about twenty cubic feet, was at this time worked by two Indians, with picks, who threw out quantities of the ore as fast as it could be broken up. This place has been resorted to by the Indians from time immemorial, for vermillion, to apply to their interesting persons; but the value of the deposit was first ascertained by Señor Castillero. This gentleman was educated at the school of mines in the city of Mexico; and having visited California, his superior knowledge enabled him to detect the value of this mine, which he at once "*denounced*," * and commenced working.

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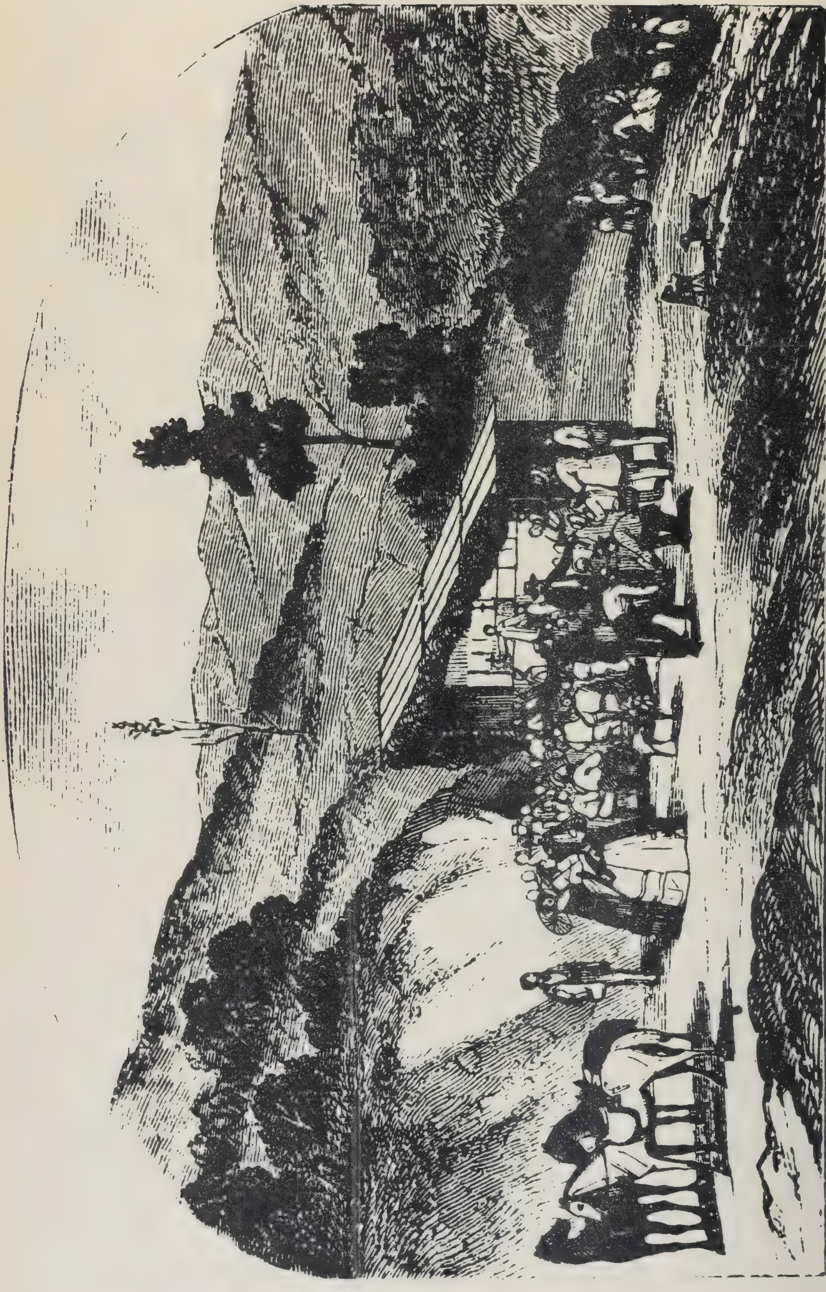
† From *A Tour of Duty in California, by Joseph Warren Revere, Lieutenant, U. S. Navy, New York, 1849*, in the collection of The Society of California Pioneers, San Francisco, California.

* Any one who discovers a mine, although it be on land not his own, may, by the law of Mexico, *denounce* it (as it is called) to the authorities. If he works it, the produce becomes his, under certain restrictions. [*Original text note.*]



THE HENRIQUITA QUICKSILVER MINE, ON THE MORNING OF DEDICATION. From *Scenes of Wonder and Curiosity in California . . .* published by J. M. Hutchings & Co., *San Francisco, 1862,* in the collection of the California State Division of Mines, San Francisco.

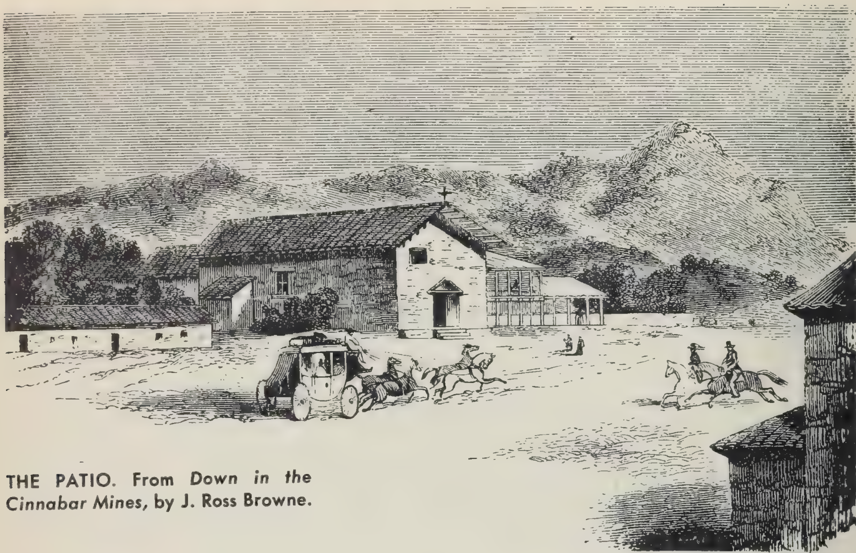
REV. C. S. LYMAN
On Mines of Cinnabar in Upper California *

1848

6. *Mines of Cinnabar in Upper California*, (communicated for this Journal by Rev. C.S. Lyman, in a letter dated Pueblo de San José, March 24, 1848.)—The mine of New Almaden is situated a few miles from the coast, about midway between San Francisco and Monterey, and in one of the ridges of Sierra Azul mountain. The mouth of the mine is a few yards down from the summit of the highest hill that has yet been found to contain quicksilver, and is about 1200 feet above the neighboring plain, and not much more above the ocean. This hill extends longitudinally in a northwesterly direction, decreasing in height; and in various parts of it, for several miles, traces of the ore have been found, and some openings have been made which promise to be valuable. This range of hills consists of a variety of rocks, which I have not yet had an opportunity properly to study. The prevailing one is a greenish talcose rock, which seems to embrace the bed of ore at the New Almaden mine both above and below. A specimen from the rock immediately contiguous to the ore, is contained in the box. The ore is interspersed through a yellow ochreous matrix, which forms a bed 42 feet in thickness, dipping northwesterly at an angle of about 45°. The richest ore, is at present found in the upper part of the bed, the poorer ores being taken from the lower portion.

This mine, known to the aborigines from time immemorial as a "cave of red earth," from which they obtained paint for their bodies, was first discovered to contain quicksilver about four years since, during experiments made by some Mexicans to smelt the ore for the purpose of obtaining gold, which they supposed it to contain. About two years ago it fell into the hands of Barron, Forbes & Co., who sent on hands, tools and funds to commence working it. Unfortunately the vessel fell into the hands of the United States forces, and was confiscated; the operations of the mine were of course delayed till the arrival of Mr. Forbes himself a few months since, with miners, tools, and whatever things he was able to procure in Mexico, to enable him to make a fair experiment on the capabilities of the mine. The great trouble was to obtain suitable apparatus for extracting the ore. At length four potash kettles were found, which were set in a furnace of adobies, with condensers of mason-work immediately adjacent—a wretched apparatus indeed for managing so subtle a thing as mercurial vapor. While I was at the mine, the daily mode of working was to fill these pots in the morning with 1600 lbs. (400 to each pot) of the ores of average quality, broken in lumps of the size of apples, put on the covers and *lute* them with a layer of *sand*. The fires were then kept up till near night, when the furnaces were allowed to cool gradually. The next morning the condensers were opened, and the metal dipped up; which usually amounted to from 200 to 300 pounds for the four pots. This was a much less per-centage than the assay indicated, and it was obvious that a large portion of metal was lost. The upper parts of the pots and condensers were found to be generally coated with a crust of sulphuret of mercury, of which

* From *The American Journal of Science and Arts, conducted by Professors B. Silliman, Jr., and James D. Dana. Second Series. Vol. VI.—November, 1848. New Haven: Printed for the Editors by B.L. Hamlen, Printer to Yale College*, in the collection of the University of California Library, Berkeley, California.



THE PATIO. From *Down in the Cinnabar Mines*, by J. Ross Browne.

THE ROAD TO THE MINE . . . Wagons, heavily laden with ores, pass down to the Reduction Works; and the sounds of hammer and anvil and whistling steam-engines, and the dull reverberation of the subterranean blasts, give evidence of the prevailing interests that bind the community together. From *Down in the Cinnabar Mines. A Visit to New Almaden*, by J. Ross Browne, Harper's New Monthly Magazine, October 1865, in the collection of the California State Library, Sacramento.

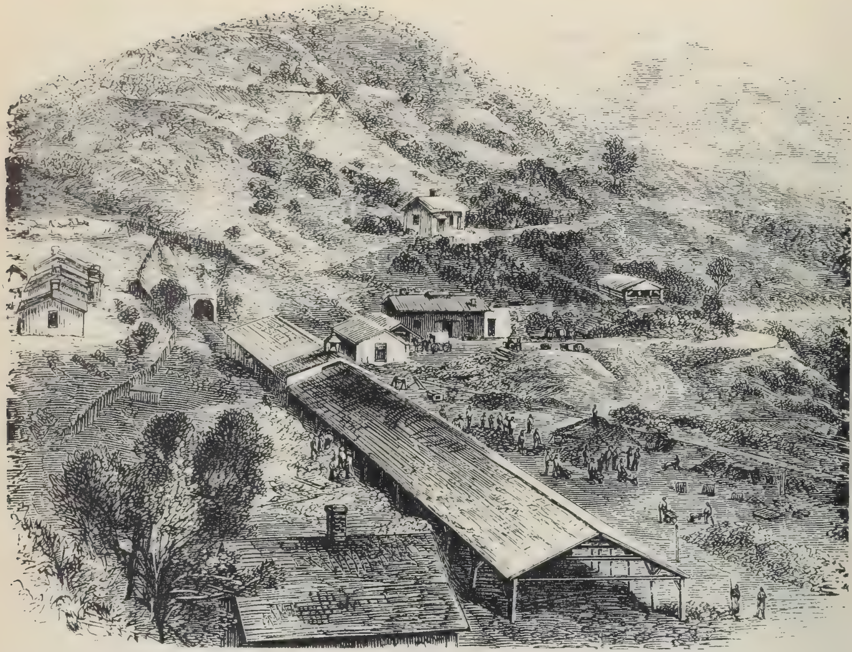
No. 15 is a small specimen. Mr. Forbes wished to devise some way of extracting the metal without mixing lime with the ore in the roasting, but was unsuccessful. At length a kiln of lime, which occurs in the immediate vicinity, was burned, and I am informed that, mingled with this, the ores yielded a vastly larger percentage of metal. In the last three weeks, about 10,000 pounds of metal have been extracted with the same apparatus, being a yield of over 50 per-cent. Whether the ores were picked or not, I cannot say, but presume they were. Between 15,000 and 20,000 pounds have been extracted in about two months, only six miners having been employed in digging the ore, and the hands of the establishment, all told, miners, furnace men, wood-choppers, &c., &c., numbering only a score. The mine is probably yielding a nett profit of $100,000 a year, with its present crude apparatus. With suitable furnaces and iron cylinders or retorts, the mine would easily yield $1,000,000 and upwards. Mr. F. sails to Europe shortly for the apparatus necessary. The bed has as yet been followed but a few hundred feet, but the ores grow more and more rich and abundant.

The other mines opened in the vicinity, have not yet been sufficiently developed to decide upon their character. Ore has been found in fifteen or twenty other places within a few miles around, and within a few days in hills that do not seem to belong to the same range with that which contains the mine already described.

Some ores of silver have also been recently discovered in this region. But I have had no opportunity of procuring any genuine specimens as yet, and whether silver mines worth the working will be found, is at least problematical.

There are traces of coal in the country, but nothing of value has yet been discovered.

Gold has been found recently on the Sacramento, near Sutter's Fort. It occurs in small masses in the sands of a new mill race, and is said to promise well.



ENTRANCE TO THE PRINCIPAL MINE . . . The Almaden mine, from which the largest amount of ore has been obtained, is situated near the summit of a hill, and is distant about a mile and a half from the Reduction Works. In this occurs the great Ardilla "labor"—the largest deposit of cinnabar ever found in California, and probably the largest in the world. Owing to the difficulty of blasting the hard rock at a great depth from the surface, explorations have been recently made which have resulted in the discovery of large bodies of ore in the soft ground on the slopes of the hill. A new and extensive tunnel now taps some of the richest veins ever found in this mine, and its productions have largely increased.

The Cora-Blanca, a thousand yards easterly from the Almaden, has recently been discovered and prospected, and the results are highly encouraging.

The Road Tunnel and the San Juan are producing extremely rich ores; and the Buena Vista, which is 2820 feet in length, has been extensively worked with very fine results. The San Francisco, another tunnel, has developed immense quantities of ore; and the Velasquez is regarded as one of the most promising in the Company's possessions. . . .

The America, or Bull Run, commenced in 1863, has developed immense cinnabar deposits, which alone would constitute a vast and inexhaustible mine. In this the vein is regular and well-defined, the ores rich, and the general indications most promising; but the great abundance of rich metal in other mines easier of access has caused the America to be but little worked.

In addition to these there are in the Arroyo de los Capitancillos, which runs northwesterly from the elevated point upon which the America is situated, a series of valuable mines worked by the old company, comprising many rich veins, among which may be named the Providencia, the Enriqueta, the San Antonio, and La Purissima. Furnaces and reduction works were established many years ago near the centre of these mines; but owing to the development of new leads in closer proximity to the principal hacienda, they have not been used to any extent during the past few years; and the mines are now only partially worked with a view of keeping them in good condition. The Enriqueta alone has produced about a million three hundred thousand pounds of quicksilver, and is considered one of the most valuable mines on the great cinnabar range.

It will thus be seen that there is no probability, and scarcely a possibility of any deficiency of ores. The policy seems to be, as in other kinds of mining, to work only where the ores can be most conveniently and abundantly obtained, proximity to the reduction works being an important consideration. . . . From *Down in the Cinnabar Mines*, by J. Ross Browne.

MRS. S. A. DOWNER

On Her Trip Into the New Almaden Mine *

1854

This mine [New Almaden] is situated in the southern portion of the county of Santa Clara, at a distance of thirteen and a half miles from the pueblo of San José. During the spring or early summer months a more beautiful route can scarcely be traveled, the road running the whole distance through the most lovely portion of the San José Valley. This mine constitutes a portion, or a continuation, of the coast range, in the approach to which the ascent is so gradual, that, assisted by the lofty range forming the back-ground of the picture, one can scarcely be persuaded that he is not descending; or that the water, which is conducted for miles for the purposes of irrigation, does not run up hill. For more than a quarter of a mile before approaching the base of the mountain, the traveler comes upon a row of neat cottages, some six or eight in number, forming quite a little hamlet. Some of these are of large size, and are handsomely finished; each inclosed with a paling fence, containing in front a small flower-garden with shrubbery, while a vegetable garden in the rear bespeaks usefulness combined with taste and beauty. These cottages are occupied by the families of the superintendents of the works. From thence is a brick-yard, where are manufactured the bricks used in the construction of the furnaces and other works. The brick is of the best description; and surrounding the yard stand the cabins, bush arbors, or tents, of the laborers employed, who are chiefly Mexicans. Next follows the hotel—New Almaden House—a long, low building, of not very imposing appearance; and beyond is the gate opening into the works, which now occupy some four or five acres, running up to the side of the mountain, which now seems to inclose him on every side.

Directly in front of the hotel a luxuriant growth of wild oats reaches far up the side of the mountain, while to the left, peak after peak rises in majestic beauty, crowned to their summits with a rich verdure, and dotted over with oaks of noble growth. Around the side winds the road, constructed at immense cost and labor, for the transportation of ore from the mountains to the *hacienda* below. And now behold us, on a very lovely morning, seated by the side of the driver, in one of the wagons used for this purpose. This was not the most dainty conveyance imaginable, and being placed over four hundred pounds of powder, to be carried up for use of the mine, the reflection involuntarily suggested itself—"Should spontaneous combustion take place, there will certainly be an end of us." No such catastrophe occurred; and the road, winding and turning up the mountain side, disclosed new beauties at every foot of the distance. At the right was a deep ravine, through which flowed a brook, supplied by springs in the mountain, and which, in places, was completely hid by tangled masses of wild-wood, among which we discerned willows along its edge, with oak, sycamore and buckeye. Although late in summer, roses and convolvuli, with several varieties of floss were in blossom; with sweet-briar, honeysuckle, and various plants, many of which were unknown to us, not then in bloom, and which Nature, with prodigal hand, has strewn in bounteous profusion over every acre

* From *The Quicksilver Mine of New Almaden. By Mrs. S.A. Downer.* In *The Pioneer; or, California Monthly Magazine, edited by F.C. Ewer. Vol. II, pp. 220-228, October 1854. San Francisco,* in the collection of the California State Library, Sacramento.

BLASTING IN THE LOWER MINE . . . Blasting has been used with great success. It is found to facilitate the labor of the miners fifty percent., and is attended with no danger—none of the explosive gases which produced Sir Humphrey Davy's safety-lamp being known. But few who have ever witnessed a heavy "blast" will forget the effect, especially when seen for the first time. After the charge is placed everybody retires and awaits the result from behind the supporting pillars of ore, or from some secure indentation in the cavern. For a while all is silent, and nothing is heard but the burning of the fuse. But immediately the cave lightens up with a lurid flame, shedding an intense glare upon the craggy walls. The motionless faces of the miners, the damp crystalline sides of the mine, the distant and still darkened excavations, into whose tortuous windings the light has not fully penetrated, all appear and disappear in the twinkling of an eye, leaving the place by contrast in inky blackness, while the report reverberates and bellows along the passages followed by a shower of stones; for the blast does not merely open a ledge as in blowing granite, but sends innumerable splinters of rock and ore far and near. Gradually the accustomed light of the candles reveals the impression made, and the workmen return to their duties. No accidents have yet resulted from the use of gunpowder.

When the smoke has ascended through the main entrance the splintered fragments are collected, and, if too large to be placed in the panniers, or talegos, of the carriers, they are broken into pieces with bars. . . .

. . . Nor do the miners neglect the forms of religion. Like devout Catholics they attend mass at stated periods at Santa Clara, and now and then have the Padre come over to help along their labors with a benediction or two. Besides this, they have in one of the recesses a shrine appropriated and dedicated to the holy protectress of the mine. This is a niche hewn with more than ordinary care out of the solid rock, in which is placed a small figure of the tutelary saint before whom propitiatory candles are constantly kept burning. Her ladyship is clad in a handsome white gown with red morocco slippers, bead eyes, and any quantity of head-dress and ornaments. This is "Nuestra Señora de Guadelupe," before whom the miners regularly prostrate themselves to supplicate her protection from fire-damps, cavings, and sudden outbursts of water. Of the first, as has already been remarked, there is no danger; of the second, no instance has occurred, as the galleries are well stanchioned; and though of the latter all live in constant anxiety, the mine has remained so dry up to this time as to need no artificial drainage. . . . From *A Visit to the Quicksilver Mines of New Almaden,* by William Vincent Wells, Harper's New Monthly Magazine, June 1863, in the collection of the California State Library, Sacramento.

of the land. To the left of the mountain side, the wild gooseberry grows in abundance. The fruit is large and of good flavor, though of rough exterior. Wild oats, diversified with shrubs and live-oak, spread around us, till we reach the *patio*, nine hundred and forty feet above the base of the mountain. The road is something over a mile, although there are few persons who have traveled it on foot under a burning sun, but would be willing to make their affidavits it was nearer five.

Let us pause, and look around us. For a distance of many miles, nothing is seen but the tops of successive mountains; then appears the beautiful valley of San Juan, while the Coast Range is lost in distance. The *patio* is an area of more than an acre in extent; and still above us, but not directly in view, is a Mexican settlement, composed of the families, and lodging-cabins of the miners. There is a store, and provisions are carried up on pack-mules, for retail among the miners who may truly be said to live from hand to mouth. We are still three hundred and thirty-three feet below the summit, where in 1845 a shaft was sunk, and mining first commenced. This point had been the resort of the aborigines not only of this State, but from as far as the Columbia river, to obtain the paint (vermilion) found in the cinnabar, and which they used in the decoration of their persons. How long this had been known to them cannot be ascertained; probably a long time, as they had worked into the mountain some fifty or sixty feet, with what implements can only be conjectured. A quantity of round stones, evidently from the brook, was found in a passage, with a number of skeletons; the destruction of life having been caused, undoubtedly, by the sudden caving in of the earth, burying the unskilled savages in the midst of their labors. It had been supposed for some-time that the ore possibly contained precious metals, but no regular assay was made till in '45; a gentleman now largely interested, procured a retort, not doubting that gold, or at least silver, would crown his efforts. Its real character was made known by its pernicious effects upon the system of the experimenter. The discovery was instantly communicated to a brother, a member of a wealthy firm in Mexico, who with others purchased the property, consisting of two leagues, held under a Spanish title, of the original owner. For some years but little was done. The ore proved both abundant and rich, but required the outlay of a vast amount of capital to be worked to advantage; and, while Nature with more than her usual liberality had furnished in the mountain itself all the accessories for the successful prosecution of her favors, man was too timid to avail himself of her gifts. In 1850, the present company was formed. With untiring energy, guided by a liberal and enlightened policy the work proceeded with vigor, and at this time, the works being nearly completed, the extraction of the mercury proceeds without interruption.

In 1850 a tunnel was commenced in the side of the mountain in a line with the *patio*, and which has already been carried to the distance of 1100 feet by ten wide, and ten feet in hight to the crown of the arch, which is strongly roofed with heavy timber throughout its entire length. Through this the rail-track passes; the cars, receiving the ore as it is brought on the back of the carriers, (*tenateros*) from the depths below, or from the hights above. The track being free, we will now take a seat on the car, and enter the dark space. Not an object is visible, save the faint torch-light at the extreme end; and a chilling dampness

TENATEROS CARRYING THE ORE FROM THE MINE. From *Scenes of Wonder and Curiosity in California,* in the collection of the California State Division of Mines, San Francisco.

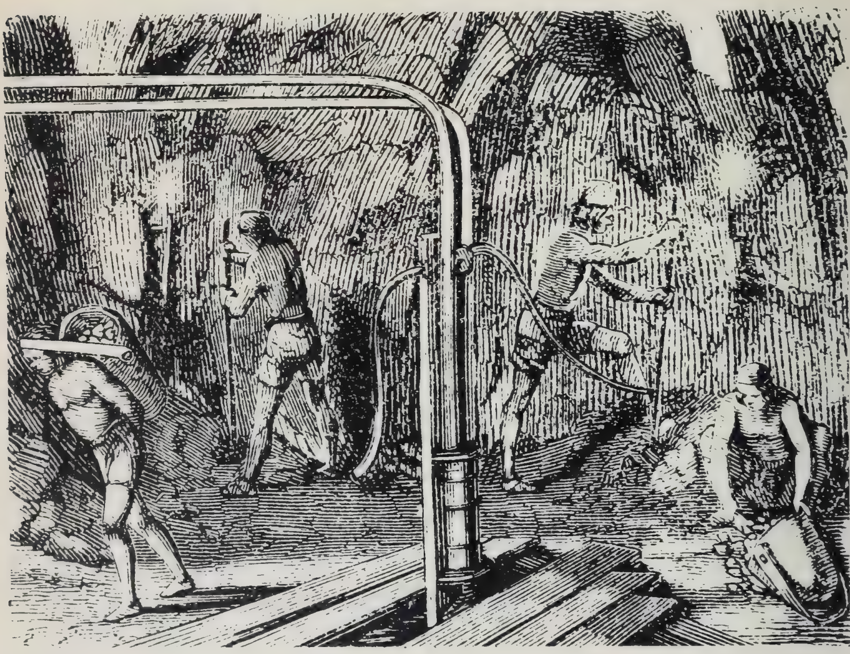
seizes on the frame, so suddenly bereft of warmth and sunshine. This sensation does not continue as we descend into the subterranean caverns below, and now commence the wonders, as well as the dangers of the undertaking. By the light of a torch we pass through a damp passage of some length, a sudden turn bringing us into a sort of vestibule, where, in a niche at one side, is placed a rude shrine of the tutelary saint, or protectress of the mine—*Nuestra Señora de Guadalupe*, before which a lighted candle is kept constantly burning. You descend a perpendicular ladder formed by notches cut into a solid log. You go down, perhaps twelve feet; you turn and pass a narrow corner, where a frightful gulf seems yawning to receive you. Carefully threading your way over the very narrowest of footholds, you turn into another passage black as night, to descend into a flight of steps formed in the side of the cave, tread over some loose stones, turn around, step over arches, down into another passage, that leads into many dark and intricate windings and descendings, or chambers supported but by a column of earth,—now stepping this way, then that, twisting and turning, all tending down, down to where, through the darkness of midnight

one can discern the faint glimmer, which shines like Shakespeare's "good deed in a naughty world," and which it seems impossible one can ever reach. We were shown a map giving the subterranean topography of this mine; and truly, the crossings and re-crossings, the windings and intricacies of the labyrinthine passages could only be compared to the streets of a dense city, while nothing short of the clue, furnished Theseus by Ariadne, would insure the safe return into day, of the unfortunate pilgrim, who should enter without a guide.

The miners have named the different passages after their saints, and run them off as readily as we do the streets of a city; and after exhausting the names of all the saints in the calender, have commenced on different animals, one of which is not inaptly called *El elefante*. Some idea of the extent and number of these passages may be formed, when we state that sixty pounds of candles are used by the workmen in the twenty-four hours. Another turn brings us upon some men at work. One stands upon a single plank placed high above us in an arch, and he is drilling into the rock above him for the purpose of placing a charge of powder. It appears very dangerous, yet we are told that no lives have ever been lost, and no more serious accidents have occurred than the bruising of a hand or limb, from carelessness in blasting. How he can maintain his equilibrium is a mystery to us, while with every thrust of the drill his strong chest heaves, and he gives utterance to a sound, something between a grunt and a groan, which is supposed by them to facilitate their labor. Some six or eight men working in one spot, each keeping up this agonizing sound, awakens a keen sympathy. Were it only a cheerful sing-song, one could stand it; but in that dismal place, their wizzard-like forms and appearance, relieved but by the light of a single tallow candle stuck in the side of the rock, just sufficing to make "darkness visible," is like opening to us the shades of Tartarus; and the throes elicted from over-wrought human bone and muscle, sound like the anguish wrung from infernal spirits, who hope for no escape.

These men work in companies, one set by night, another by day, alternating week about. We inquired the average duration of life of the men who work under ground, and found that it did not exceed that of forty-five years, and the diseases to which they are most subject are those of the chest; showing conclusively how essential light and air are to animal, as well as vegetable life. With a sigh and a shudder, we step aside to allow another set of laborers to pass. There they come; up, and up, from almost interminable depths; each one as he passes, panting, puffing and wheezing, like a high-pressure steamboat, as with straining nerve and quivering muscle, he staggers under the load, which nearly bends him double. These are the *tenateros*, carrying the ore from the mine to deposit it in the cars; and like the miner he is burdened by no superfluous clothing. A shirt and trowsers, or, the trowsers without a shirt; a pair of leathern sandals fastened at the ankle, with a felt cap, or the crown of an old hat, completes his costume. The ore is placed in a flat leather bag, (*talégo*) with a band two inches wide that passes around the forehead, the weight resting along the shoulders and spine. Two hundred pounds of rough ore are thus borne up, flight after flight, of perpendicular steps; now winding through deep caverns, or threading the most tortuous passages; again ascending over earth or loose stones, and up places that have not even an apology for steps, all the while lost in Cimmerian dark-

MEXICANS REFINING QUICKSILVER. From *Scenes of Wonder and Curiosity in California*, in the collection of the California State Division of Mines.



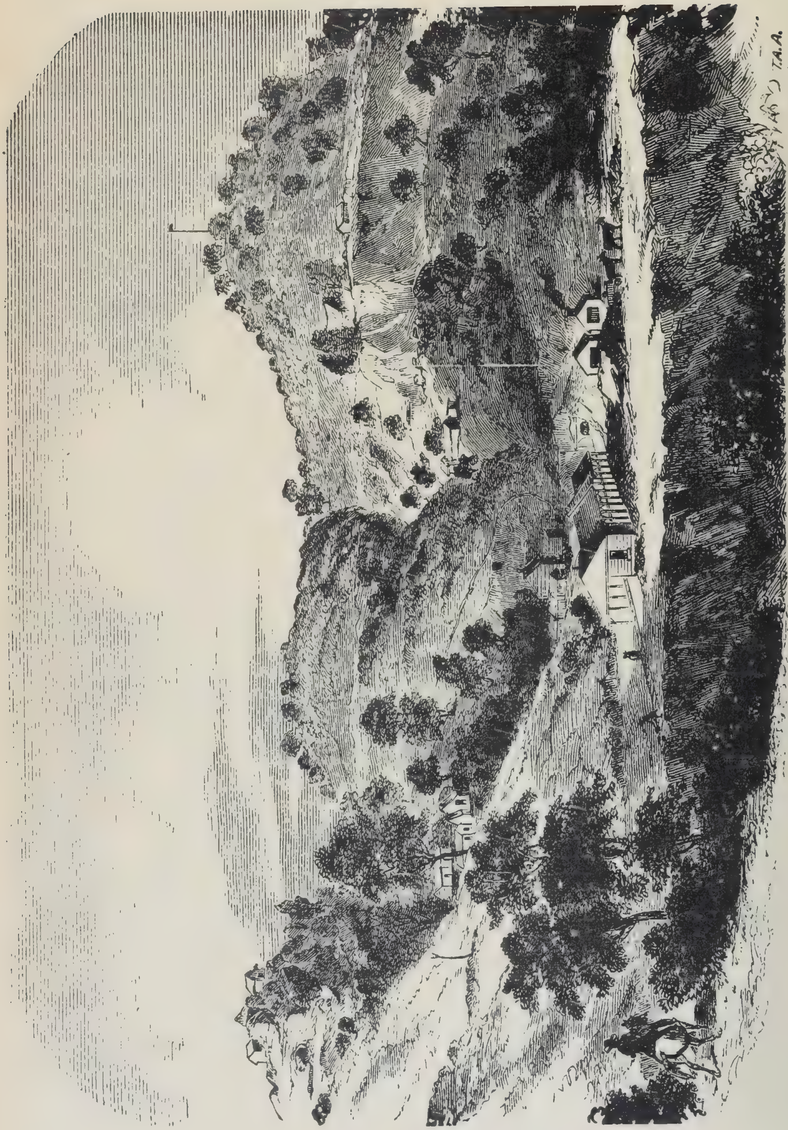
MINEROS AT WORK IN THE MINE. From *Scenes of Wonder and Curiosity in California*, in the collection of the California State Division of Mines.

ness, but for a torch borne aloft, which flings its sickly rays over the dismal abysm, showing that one unwary step would plunge him beyond the possibility of human aid or succor. Not always, however, do they ascend; they sometimes come from above; yet we should judge the toil and danger to be nearly as great in one case, as in the other. Thirty trips will these men make in one day, from the lowest depths.

For once we were disposed to quarrel with the long, loose skirts, that not only impeded our progress, but prevented our attempt to ascend to the summit, and enjoy from thence a prospect of great beauty and extent. But one woman, we believe, has even accomplished this feat, which severely tasks the strength of manhood.

We will now follow the *tenateros*, as they load the locomotive with the contents of their sacks, and run after it into the open air. There they go, with shouts of laughter, and really, as one emerges into the warm sunshine, the change is most inspiriting. They have reached the end of the track, and throw off the great lumps of ore, without an effort, as if they were mere cabbages. What capacious chests, and how gaily they work! Such gleeful activity in men we never before beheld. The large lumps deposited, they now seize shovels and jumping on the cars, the small lumps mixed with earth, are cleared off with the most astonishing celerity. Do but behold that fellow of Doric build, with brawny muscles, and who is a perfect *fac simile* of Hercules, as he stood engraved with his club, as we remember him in Bell or Tooke's Pantheon! What a complete model for a sculptor! And now they are off again to resume their toil, giving an impetus to the car, as full of play and frolic as boys let loose from school. Can it be that these are the same men that so strongly excited our sympathies, but a few moments since, while staggering under their heavy sacks? Truly, is the back fitted for the burden, and there is a mercy, doubtless, in the exuberance of spirit, and the light-heartedness that enables them to make sport of their labor. So it is through life; the law of compensation runs through every phase of human existence, and there is not a suffering that has not its counterpart in some latent good, not always directly discerned.

The ore deposited on the *patio*, another set of laborers engage in separating the large lumps, and reducing them to the size of common paving stones, which are placed by themselves. The smaller pieces are put in a smaller pile, while the earth (*tierra*) is sifted through coarse sieves for the purpose of being made into *adobes*. There is also a blacksmith's shop for making and repairing implements. The miner is not paid by the day, but receives pay for the ore he extracts. They usually work in parties of from two to ten; half the number work during the day, the other half by night, and in this manner serve as checks upon each other. Should a drone get into the number, complaint is made to the engineer, who has to settle such matters, which he generally does by placing him with a set nearer his capacity, or sometimes by a discharge. The price of the ore is settled by agreement for each week. Should the passage be more than commonly laborious, they do not earn much; or if on the contrary it proves to be easy, and of great richness, the gain is theirs; it being not infrequent for them to make from thirty to forty dollars a week a piece, and seldom less than fifteen. In those parts of the mine where the ore is worthless, but still has to be extracted in order to reach



THE WORKS. From *A Visit to the Quicksilver Mines of New Almaden*, by William V. Wells, in the collection of the California State Library, Sacramento.

that that will pay, or to promote ventilation, they are paid by the vara,* at a stipulated price. They do nothing with getting the ore to the *patio*; this is done by the *tenateros* at the company's expense, as is also the separation, sifting and weighing. Each party have their ore kept separate; it is weighed twice a week and an account taken. They select one of their party who receives the pay, and divides it among his fellows.

The *tenateros* receive three dollars per diem; the sifters and weighers, two dollars and a half; blacksmiths and bricklayers, five and six, while carpenters are paid the city price of eight dollars a day. These wages seem to be very just and liberal, yet such is their improvidence that no matter how much they earn, the miners are not one *peso* better off at the end of the month than they were at its beginning. No provision being made for sickness or age, when that time comes, as come it will, there is nothing for them to do but like some worn out old charger, lie down and die. This has reference exclusively to the Mexicans; and it is a pity that a Savings Bank could not be established and made popular among them. They number between two and three hundred in all; but they are, perhaps, the most impracticable people in the world, going on as their fathers did before them, firmly believing in the axiom, that sufficient unto the day is the evil thereof.

We will now resume our seat on the wagon loaded to return, and as we do so, cannot but admire the horses—a team of four to each wagon. What noble animals, and how well they draw, seemingly no more tired with this their last load, than when they first ascended in the morning. As we approach the *hacienda*, we are again reminded that it was built for time. The warehouses are of substantial brick structure, standing within a wall, and on a line with the gate or main entrance. These buildings, with furnaces, blacksmith shop and an open space for the manufacture of adobes, are all within the inclosure, and occupy a space of several acres. There are, at present, thirteen furnaces in constant operation. They are of solid masonry, stand under cover, with open, raised roofs, to admit the free escape of noxious gasses, and are in rows about six feet apart, being forty feet long by eight in breadth, and ten in hight. The fuel used is wood, cut in the mountains, and delivered at six dollars a cord. A uniform but not very high degree of temperature is all that is required. The fire occupies the first compartment at one end, with numerous conductors for the heat to pass through the furnace in which the ore is placed. This receptacle is four feet in width, six in length, and five feet high. It will contain 15,000 pounds of ore, or 12,000 pounds of adobes. Each furnace requires twelve or fourteen condensers, through which the vapor, as it flies off, is conducted along numerous chambers, alternating above and beneath, until it reaches the end where it passes through a wooden cistern, ten feet long by four in breadth, and two in depth. These cisterns are kept half filled with water, over which the smoke passes and cools on its way to the chimneys, which are of wood—each chimney having a separate condenser. The length of time required for the extraction of the quicksilver, is about fifty-six hours from the solid ore, and fifty from adobes. Each condenser is fitted with a small pipe through which the condensed vapor, or quicksilver, flows in streams along a narrow trough, then through another pipe into iron vats, the size of a half hogshead, placed in the ground. From these vats the molten liquid is ladled out

* A *vara* is two feet and nine inches. [*Original text note.*]

into scales; its weight is accurately determined and it is then poured into wrought iron flasks, a foot and a half in length by eight inches in diameter and a quarter of an inch thick. Each flask contains seventy-five pounds, and, when filled, is placed in a heavy vice, where the stopper is screwed down and secured. These flasks are imported from England; and the impossibility of obtaining them at the right time, occasioned a serious loss to the company at their outset, they being compelled to use large cylinders or even wooden boxes, through the cracks of which the quicksilver escaped, as well as by evaporation.

The furnaces, which are flat, are filled from the top. The ore is wheeled in and handed down to a man, who carefully places it in such manner that the heat may permeate through every portion. A white vapor flies off and passes through the opposite conductors into the condensers. The top of the furnace being bricked up, is closely covered with fresh mortar, on which is placed a thick layer of dry ashes, that no vapor may escape. This is also done at the mouth, and over each condenser. Five times in each month the charge is renewed; and after each charge the soot is scraped from off the tops and sides of the condensers, and, being mixed with ashes and water, again undergoes the action of heat, being usually placed on the top of the ore when the furnace is nearly filled.

Notwithstanding the precautions used, the escape of arsenic with the sulphate of mercury, has a deleterious effect upon those who labor among the furnaces. Each man works one week out of four, and then changes to something else. Even cattle, if allowed to browse at large in the vicinity during the dry season, become salivated, and die from its effects. Ten men only are required in this department, as but half the number of furnaces are filled at one time. Two act as firemen by day, who also weigh the liquid, and fill the flasks; two as night-watchmen, who act alternately, assisting by day in the other departments, or in extracting the dross from the vacant furnaces, and filling them, two and a half days apart. There is one foreman attached to this department, who also superintends the manufacture of adobes. As the loaded wagons come down from the mines, they deposit their contents on a platform in the rear, and on a line with the tops of the furnaces. The large lumps are placed on one side, the small lumps on the other, while the dirt is wheeled off to the open space in front, and, mixed with water, is made into adobes. Adobes are made during the summer or dry season, and but a small number can be stored for winter use. The fluid is extracted from them during the summer. They require a less amount of heat than the ore; a certain proportion of which, however, in small pieces, is usually introduced with them into the furnaces. The water used, is brought in pipes from the mountain. Except that the fires are not allowed to go out, no labor is permitted on the Sabbath, and ten hours constitute a day's work.

In the treatment of their employees, the company has been guided by a liberal spirit—securing the best men, and retaining them by their best interests. Had the ore proved less rich, or had not a far-seeing and enlightened policy actuated them, the company would, ere this, have been plunged into irretrievable ruin, as their outlays have amounted to but little short of their full proceeds. They are now in a prosperous condition; but it must be recollected that, unlike metals possessing a circulating medium, the demand for quicksilver is limited and the returns extend over many months. The furnaces and other works are nearly

completed, and the miners have reached a depth of 127 feet from the *patio*, or 462 feet beneath the summit of the mountain. . . . .

The mines of Almaden in Spain, from which this mine derives its name, have been worked for more than two thousand years, and have reached a great depth. The ore does not average over ten per cent. of quicksilver. At the mine of New Almaden, the average yield is thirty-eight, and has reached as high as fifty per cent. Nothing less, indeed, would have enabled it to compete with its Spanish rival, where convict labor is alone employed, and which has the monopoly of the European market, beside furnishing a large amount to Mexico and South America. The amount of quicksilver used in California, is much less than is generally supposed. Notwithstanding the increase of gold mining, the whole amount for home consumption, does not exceed one hundred flasks per month. The exports to Chile and China, are not large; much of that imported by the latter country, is mixed with sulphur and re-converted into the vermilion of commerce. Seven-ninths of the sales are made to Mexico, where it is extensively used in the silver mines of that country. The ore at New Almaden, does not run in veins, or leads, but is found in pockets. It may last for ages; and, again, such is the uncertainty connected with mining, it may suddenly cease, the supply becoming exhausted; or the company may be compelled to abandon their work from the sudden rushing in of water.

THE HACIENDA. From *A Visit to the Quicksilver Mines of New Almaden*, by William V. Wells, in the collection of the California State Library, Sacramento.

JOHN KEAST LORD

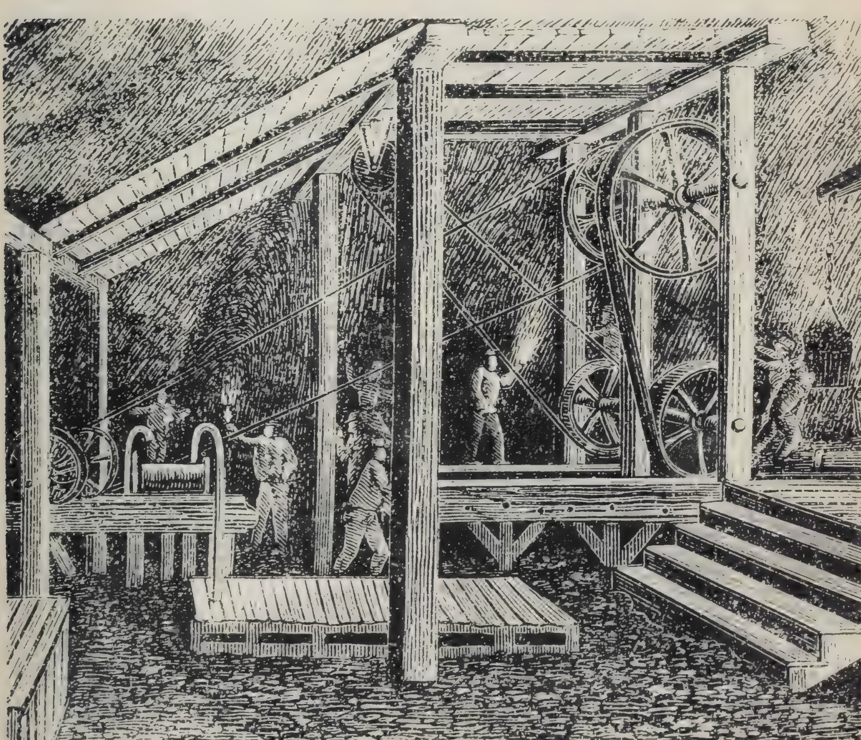
On His Trip Into the New Almaden Mine *

1860

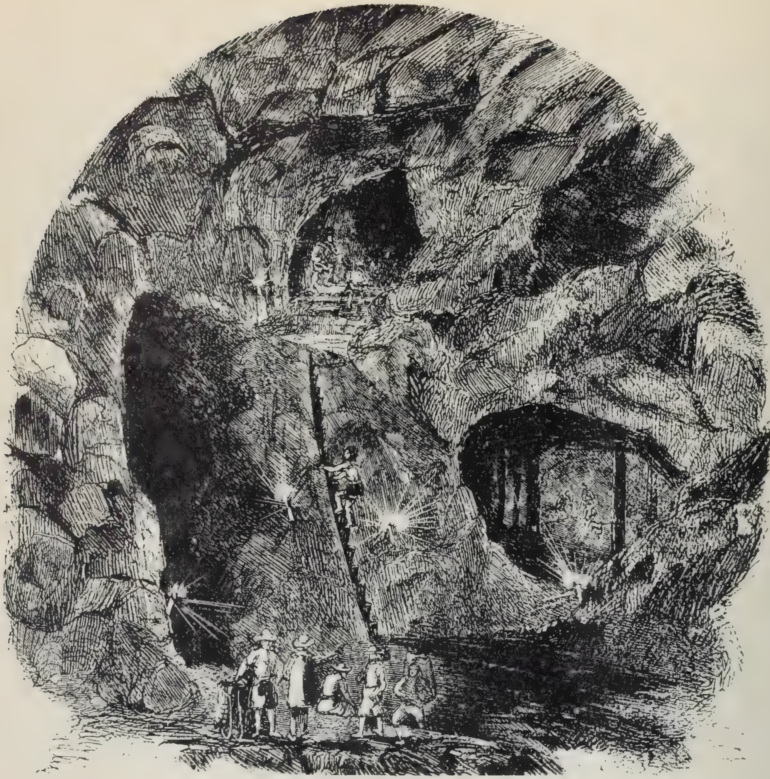
March 6th [1860].—. . . . . The lower village of Almaden consists of a long row of very pretty cottages, the residences of the workmen employed in smelting the ore; each cottage was completely buried with honeysuckle and creeping roses; the gardens in front filled with flowers, and at the back with vegetables and fruit. A small stream of water, clear and cold, ripples past the frontage, brought from a mountain-burn that runs swiftly at the back, a barrier dividing the gardens from the surrounding hills. An avenue of trees leads from the cottages to the spacious brick buildings used for smelting. . . . .

The mine is about a mile and a half from the smelting-works, on the side of a mountain; an admirable road leads to it by a gentle ascent, down which waggons drawn by mules bring the ore to be smelted. On reaching the summit I rested on

* From *The Naturalist in Vancouver Island and British Columbia. By John Keast Lord, F.Z.S. Naturalist to the British North American Boundary Commission. In Two Volumes—Vol. I. London: Richard Bentley, New Burlington Street, Publisher in Ordinary to Her Majesty. 1866.*, in the collection of The Bancroft Library, University of California, Berkeley.



HOISTING CHAMBER. From *Down in the Cinnabar Mines*, by J. Ross Browne, in the collection of the California State Library, Sacramento.



GALLERIES AND INCLINED SHAFTS. . . . The main entrance to the mine is a tunnel, commenced in 1850, in the side of the mountain, in a line with the patio, and which has already been carried to the distance of 1800 feet, by 10 wide and 10 feet in height to the crown of the arch, which is strongly roofed with heavy timber throughout its entire length. Through this an iron rail track passes, the cars receiving the ore as it is brought upon the backs of carriers (tanateros) from the excavations. These cars are calculated to carry about a ton each, and are pushed rapidly in and out by hand.

We enter the car and in a few moments are rumbling along this under-ground railroad, with no sound to break the silence besides the heavy breathing of our human propellers, who, with swarthy visage lighted up by the dim rays of the candles, seem almost ghastly as they bend to their work. These laborers are all Mexicans, and have generally served a sort of apprenticeship in the silver mines of Spanish America. Soon we reach the terminus of the railroad, and step out upon a damp soil beaten hard by the incessant tramp of the ore-carriers. Here the sensation of chilling dampness usually possessing the novice on entering a subterranean cavern seizes one, and makes him for a moment doubt the prudence of the adventure; but this gradually wears away, and a feeling of curiosity succeeds. . . .

. . . With a stout Mexican to act the part of torchbearer, we pass along a damp passageway, through the arched roof of which the water trickles, and in the rainy months hangs in drops, glittering like gems in the light of the candles. We next pass down a perpendicular piece of accommodation, known among the miners as an escalara, or ladder, which consists of a notched stick of timber some twelve feet in length, answering to the common "samson-post" in a ship's lower hatchway. This leads to a small landing-place, from which we gaze down into a black pit, the darkness made visible by the uncertain flicker of the candles. It is dainty treading along the little shelf, where a misstep would send you headlong into some unknown chasm, whose depth is indicated by the noises of the laborers far below, which ever and anon comes faintly up. A short interval of groping, with the peculiar uncertain feeling of not knowing whether the next step is likely to be upon solid ground or into emptiness, and we commence the descent of a flight of steps cut into the wall of rock, which leads into a still deeper cave. Here, feeling our way cautiously among loose stones and along craggy sides of the cave, we follow the glimmering candles,

now down a slippery inclined plane, and again struggling up the precipitous base of some vein of cinnabar, which in its erratic course seems to have shot through the solid heart of the mountain, in much the zigzag course that a drop of quicksilver would describe in rolling about the surface of a plate. It is not until the lowest and inner excavations are reached that we realize the labyrinthine intricacies we have traversed. We are more than 200 feet below the patio and 600 below the summit of the mountain. . . .

. . . About 300 persons are employed in the mine. The work was formerly given out to them by *empresarios* or "bosses," who took the job to deliver at the mouth of the mine a certain number of tons of ore, and, of course, hired their workmen at the lowest possible wages. The laborers in the mine (barateros) are a distinct fraternity from the ore-carriers (tanateros). Each have their respective calling, and are not willing nor are they ever expected to assume each other's places. The tanateros are most muscular and the best proportioned of all those engaged in the mine. Long practice has inured them to the labor, and a first-rate man will pack 200 pounds up the escalaras without stopping to rest. This method of raising the ore is preferred to any machinery that has been suggested, as the men supply all that the works can distill, and the cost to the company is only in proportion to the amount furnished. A large sack or pannier of hide, open at the top, is slung to the back, and supported by the muscles of the neck, a method in which Spanish Americans seem to have great faith.

Two hundred pounds being the average load, it becomes a matter of pride to preserve the physical reputation. It is impossible to witness the straining nerves and quivering muscles of the carriers, as they pass slowly up from the depths below, without feeling that the heavy breathing and painful expression of face is produced by such labor as human beings can not long endure. Yet they seem cheerful, and as they deposit their burdens into the cars, light their cigarros, and join in the laugh produced by the jokes of some Joe Miller of the gang. Their dress is confined to a pair of pantaloons with the legs cut off above the knees, and a calico shirt, which is generally stowed away in some crevice until the day's work is over. A pair of leathern sandals fastened at the ankle is sometimes added to the costume. Flight after flight up perpendicular steps these muscular fellows will ascend, winding through deep caverns, or threading passages of Egyptian darkness, or, as the openings often lead up in following the tortuous windings of the veins, they may be seen cautiously descending the notched logs toward the main entrance; yet it is affirmed that no accident has ever happened. Their course is dimly lighted by the candles placed in the niches of the walls. A single misstep would dash the man and his load into the dismal abyss below; but by constant practice they attain to a wonderful degree of precision, and ascend and descend with all the certainty of mules scaling the rocky fastnesses of the South American sierras. An efficient tanatero will make from twenty to thirty trips a day. Groping about the mine, and following the glimmering light which barely illumines the way, we happen upon little groups of the barateros hard at work with crow-bars and picks breaking down the sterile rock. These fellows are, if possible, more scantily clad than their ore-carrying brethren. Some may be seen following the serpentine lead of a vein of cinnabar which has just been found to dip from the horizontal toward the base of the mountain. They have dug themselves out of sight, and their half-smothered grunts and exclamations come curiously up from the cave whose length they are slowly extending. A feeble light glimmers out of the excavation—a cave within a cave. A little farther, and we find a plank stretched across a narrow chasm upon which two or three swarthy broad-chested miners are standing, drilling their way into the solid rock above them, where a rich lead has just been found.

Long practice has taught them in running these shafts to leave immense stanchions of the ore and native rock as supports to the ceilings. Sometimes in the larger chambers where several galleries come to a point, the workmen keep a fire burning which illumines all the mines in the vicinity and throws a dull, ruddy glare upon every thing for many yards around. Then the roof reveals its millions of lustrous crystallizations, sparkling in ruddy rhomboids and glittering like some magician's cavern of fairy romance. The effect is heightened by the Cimmerian darkness of the neighboring passages deserted for newly discovered leads. . . . From *A Visit to the Quicksilver Mines of New Almaden,* by William V. Wells, in the collection of the California State Library, Sacramento.

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a level plateau, on which the upper works are built; I am to descend presently into the depths of the mine to see how the ore is deposited, and trace, step by step, the various processes it has to go through before it is marketable.

The main entrance is a tunnel ten feet high, and about an equal width throughout, in which runs a tramway loading to the shaft. At the end of this tunnel a small steam-engine does the work of the poor 'tanateros,' or carriers, who, until very recently, brought the ore and rubbish from the bottom of the mine on their

backs, a system still adopted in Spain and Peru, each man having to bring up a load of two hundred pounds, in a bag made of hide, fastened by two straps passing round the shoulders, and a broader one across the forehead, which mainly sustains the load. It was fatal work to the poor Mexicans who had to do it, the terrible muscular strain soon producing disease and death!

On reaching the engine I am undressed and rigged as a miner, a costume far more loose and easy than becoming. Three dip-candles dangled from a button on my jacket by the wicks, and one enveloped in a knob of clay for my hand, completed my toilet. The next process is to be lowered down into the mine. Squeezing myself into a huge kind of bucket, and assuming as near as practicable the shape and position of a frog, my candle lighted, 'All right!' says somebody, and I find myself rapidly descending a damp dismal hole, dripping with water like a shower. Of course I shudder, and have horrible ideas of an abyss, ending no one knows where; the candle hissed, sputtered, and went out; the bucket swang as the chain lengthened, and bumped unpleasantly against the rocks; now a sudden stop, and a lively consciousness of being dragged bodily out like a bundle of clothes, discloses the fact of my safe arrival at the bottom.

The swarthy Mexican miner deputed as guide leads the way along a narrow gulley, and down an incline to the mouth of another hole, the descent to which has to be effected on a slanting pole, with notches cut in it, very like a bear-pole, called by the miner an *escalera*, requiring a saltatory performance that would not have been so bad if I had only known where I should have landed in case of falling. After this we scramble down a flight of steps cut in the rock, and reach the lowest excavation, about one thousand feet from the surface.

The cinnabar is found in large pockets, or in veins, permeating a kind of traprock; and as the miners dig it out, large columns or pillars are left to support the roof, and prevent the chance of its falling in. A small charcoal-fire burned slowly at the base of one of these massive columns, and as its flickering light fell dimly, illuminating with a ruddy glow the bronzed faces and nearly nude figures of the miners, the vermilion hue of the rugged walls and arched roof, sparkling with glittering crystals, forcibly reminded me of a brigand's cave, such as Salvator Rosa loved to paint.

All the work is done by contract: each gang taking a piece of ground on speculation, is paid according to the amount of ore produced; the ore averaging about thirty-six percent. for quicksilver, although some pieces that I dug myself produced seventy-five per cent. Many mines in Europe have been profitably worked when the cinnabar has yielded only one per cent.

A shrill whistle rings through the mine; the miners from all directions rush towards the pillars. Thinking, at least, the entire concern was tumbling in, I was about to scamper off, when the guide, siezing my arm, drags me behind a projecting mass of rock, simply saying, 'A blast!' For a while there was a deathlike silence—not a sound save the hiss of the fusee, and the heavy breathing of the men; then the cave lighted up with a lurid flash, shedding a blinding glare over every object like tropical lightning. The dark galleries appeared and disappeared in the twinkling of an eye, whilst the report, like countless cannon, was echoed and reechoed through the cavernous chamber. Showers of fragments came rattling down in every direction, hurled up by the force of the powder. On the smoke clearing, the miners set to work to collect the scattered fragments of cinnabar.

If a blast has been successful, often many tons of rock are loosened and torn out, to be broken into small pieces and conveyed to the bucket, and hauled by the engine to the surface. The mining operations are continued night and day, seventy-four pounds of candles being consumed every twenty-four hours.

I finish the survey of this singular mine perfectly free from foul air or fire-damp; ascend as I came down; and, by vigorous rubbing with soap-and-water, am slowly restored from bright vermilion to my normal colour.

The ore, on reaching the surface, is conveyed by the tram-cart to the sorting shed, where it is broken and carefully picked over by skilful hands, great caution being needed in selection, as much valuable ore might be thrown away, or a large quantity of useless rock taken to the smelting-furnaces. The picked ore is placed in large bags made of sheepskin, weighed; and then hauled by the mules to the lower works.

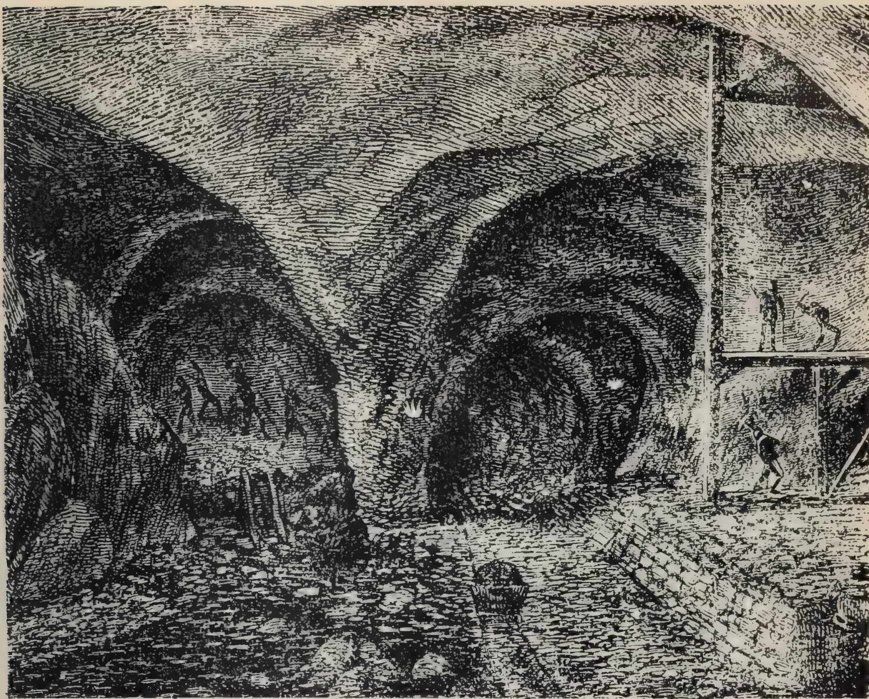
Near the mine is a primitive kind of village, the abode of the miners, sorters, and ore-carriers, who are principally Mexicans; dirty señoras in ragged finery, dirtier children devoid of garments, together with dogs, pigs, poultry, and idle miners playing monte on the doorsteps, contrast sadly with the exquisite little village at the works.

Descending from the mine to the level ground by a short track down the hill-side, through scenery indescribably picturesque, I reach the smelting furnaces; these, occupying about four acres of land, are built of brick, admirably neat, and well contrived. As quicksilver is found in several forms—namely, native quick-silver, occurring in small drops, in the pores or on the ledges of other rocks, argental mercury, a native silver amalgam, and sulphide of mercury or cinnabar, different processes are requisite for its reduction. Here it is found solely in form of cinnabar, and to reduce a kind of reverberatory furnace is used, three feet by five, placed at the end of a series of chambers, each chamber seven feet long, four wide, and five high. About ten of these chambers are arranged in a line, built of brick, plastered inside, and secured by transverse rods of iron, fitted at the ends with screws and nuts, to allow for expansion. The top is of boiler iron, securely luted.

The first chamber is the furnace for fire, the second for ore, separated from the first by a grated partition, allowing the flame to pass through and play over the cinnabar. This ore-chamber, when filled, contains ten thousands pounds of cinnabar. The remaining chambers are for condensing the metal, communicating by square holes at the opposite corners; for instance, the right upper corner and lower left, and *vice versa*, so that the vapour has to perform a spiral course in its transit through the condensers. Leaving the chambers, the vapour is conducted through a large wooden cistern, into which a shower of water continually falls, and thence through a long flue and tall chimney carried far away up the hillside.

The mercury is collected, as condensed, in gutters running into a long conduit outside the building, from which it drops into an iron pot sunk in the earth. As the pot fills, the mercury is conveyed to a store-tank that holds twenty tons. So great is its density, that a man sitting on a flat board floats about in the tank on a lake of mercury without its flowing over the edges of his raft. From this tank the metal is ladled out, and poured into iron flasks containing each seventy pounds (these flasks are made in England, and sent to New Almaden): in this state it is shipped for the various markets.

PILLARS OF HERCULES. . . . To the unlearned visitor nothing can be more bewildering than the apparent irregularity of these vast cinnabar deposits. Far down in the bowels of the earth he sees around him an endless complication of shafts, tunnels, drifts, and gloomy caverns, ramifying through the depths of the subterranean world without any appearance of system of method. His intelligent cicerone may tell him that here the vein appears; there it is worked out; in this "hilo" an immense amount of rich ore was found; in that "labor" the vein was unusually productive. Now he is on the "fourth level," and presently on the "sixth;" now he travels north, and soon, without any apparent change, finds himself going east, west, or south—all of which he professes to understand with great clearness, but which must sooner or later deprive him of all confidence in his own powers of perception. Careful observation, however, will show him in due time that there is a wonderful system in the apparent irregularity. The principal vein runs in a northwesterly and southeasterly direction, and has a length, already tested, of about five miles. It varies from fifteen to two hundred yards in width, and is subdivided into innumerable smaller veins, embracing within its outer boundaries trap, serpentine, lime, quartz, and other rocks. The deposits of cinnabar are found in these veins and chambers, running parallel with or across the principal vein; their direction being generally north and south, but varying under surrounding circumstances. By carefully observing the character and pitch of the walls, the dips, spurs, and angles of the smaller veins which ramify from the larger, and following out the minute indications furnished by each individual "hilo" or metal-bearing deposit, the intelligent miner is enabled to continue his explorations with an almost absolute certainty of success. . . . From *Down in the Cinnabar Mines,* by J. Ross Browne, in the collection of the California State Library.

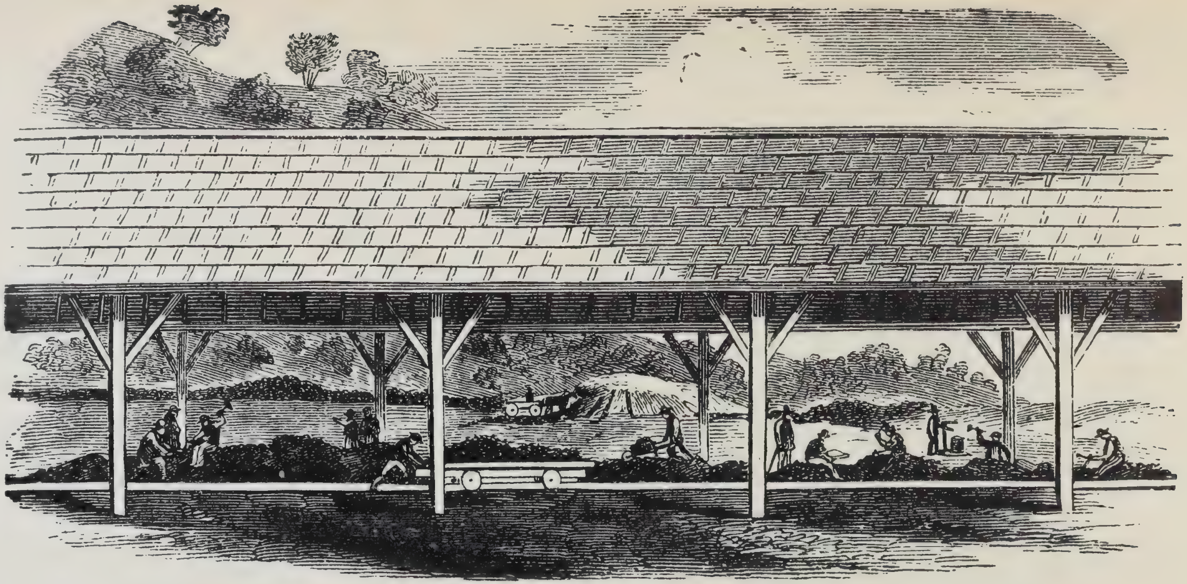


FRANCISCO VELASQUEZ CHAMBER . . . I saw myself, in a single "labor" of the Velasquez, masses of pure cinnabar that would weigh several tons each. One of them was valued at not less than eight thousand dollars. The tunnel so named opens by side-drifts into various adjacent chambers, and is 2890 feet in length. . . . From *Down in the Cinnabar Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.

Although every possible care has been taken to prevent mercurial fumes from injuring the smelters, still a great deal of it is necessarily inhaled, most injurious to health. Clearing out the furnace is the most hurtful process, the men employed working short spells, and resting a day or two between. A furnace charged with ore, I am told, takes about eight days to sublime and cool. . . . .

There are fourteen furnaces, arranged with passages ten feet wide between them, the whole covered with a roof sufficiently high to allow a current of air to circulate freely. Between the furnaces and on all the open spaces are innumerable bricks, just as we see them in a brickyard to harden before baking. On inquiring what these were made for, I discover that all the fragments and dust-cinnabar are pounded together, mixed with water, and made into bricks: in this form the ore can be conveniently built into the furnace, securing intervening spaces for the flame and heat to act on; thus more perfect sublimation is secured, and a great saving of metal effected. There are blacksmiths' and carpenters' shops and a saw-mill adjoining the furnaces.

Until recently all the ore was brought down from the mine packed on the backs of mules, a most costly system of transport as compared to the one now in use. The vegetation only suffers immediately round the chimney, and even there not to any alarming degree. The flue, being of great length, carried at a moderate slope up the hill, and terminating in a very tall chimney, completely condenses



ASSORTING THE ORE . . . The ore is prepared at the patio for the works below. The process is expeditious and simple. After being deposited by the tanateros in the cars it is brought out on the railroad to the line of sheds designated in the engraving. Here it is deposited in heaps, and attacked by a gang of assorters whose business it is to separate the fine from the coarse ore. The latter is broken in pieces suitable to the furnace, and after being cleared of all rock and earthy matter is to be carted below. The former, in the shape of siftings, is converted into bricks or cakes, like adobes, and after being thoroughly dried are deposited in one of the storehouses at the lower works. The less muscular of the workmen are employed in assorting and sifting the ore, which is broken with mallets and hammers, and weighed as it is received. In the mine there are day and night gangs constantly at work, though the unbroken darkness would never enable one to distinguish when daylight ended or commenced. More than seventy pounds of candles are burned every twenty-four hours. The operations at the big patio thus require an additional number of workmen during the day to keep pace with the night gang in the mine. . . . From *A Visit to the Quicksilver Mines of New Almaden,* by William V. Wells, in the collection of the California State Library, Sacramento.

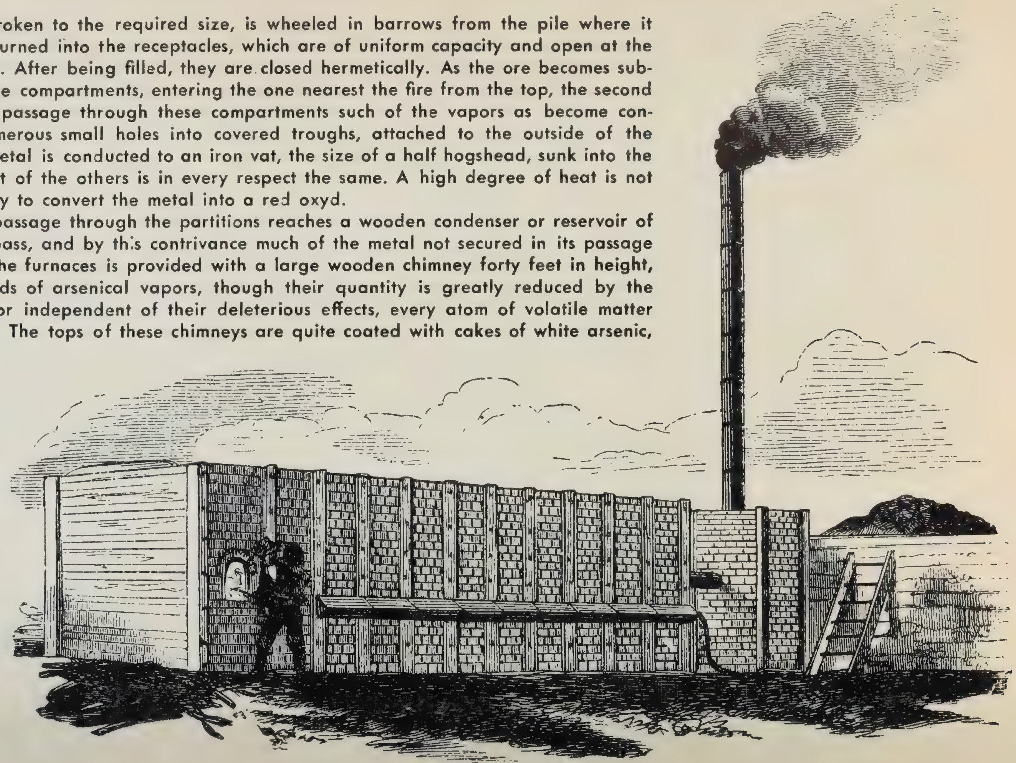
THE METAL PICKERS . . . In assorting the ore it is divided into three classes, called Gruesso, Granza, and Tierras. The first consists of the purest quality of cinnabar, carefully selected; the second is intermixed with foreign substances, and the third is the inferior class usually found in the refuse earth and loose stratum of rock abounding in the vein. . . . From *Down in the Cinnabar Mines*, by J. Ross Browne, in the collection of the California State Library, Sacramento.

THE CROSS HILL. From *Down in the Cinnabar Mines*, by J. Ross Browne.

CONDENSING FURNACE . . . Entering the works, we find a row of sixteen furnaces ranged side by side, extending a distance of several hundred feet. These stand under cover of roofs resembling those placed over a distillery, with blinds for the free escape of poisonous fumes. They stand some eight feet apart, and are forty feet in length, ten in height, and eight in breadth. . . .

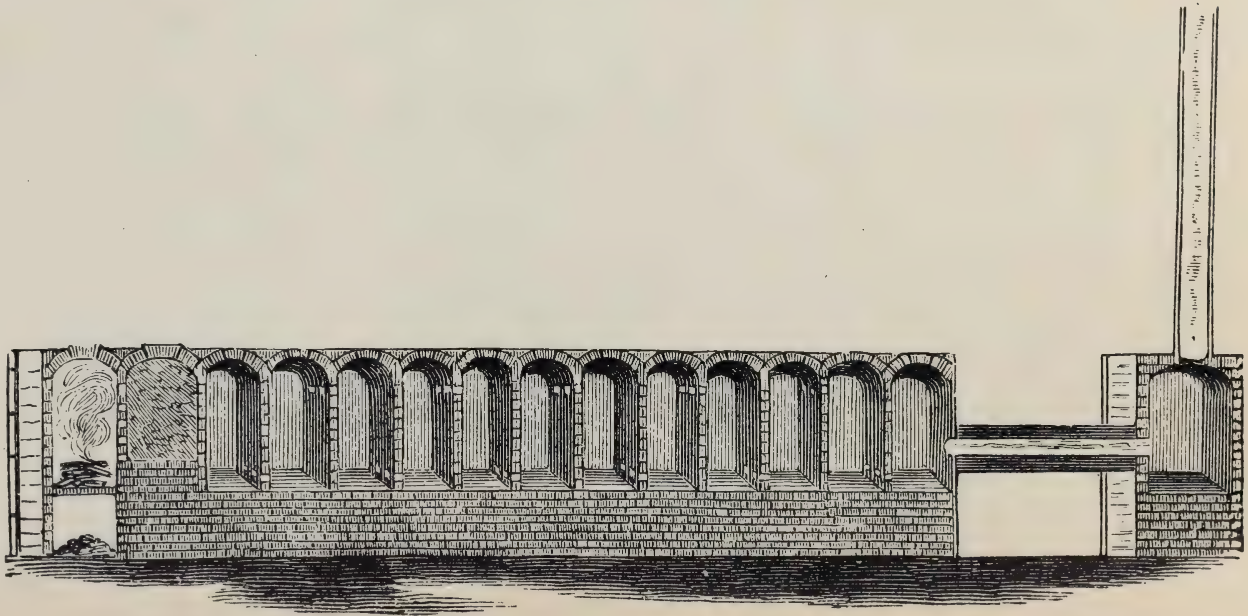
The ore, after being thoroughly cleaned and broken to the required size, is wheeled in barrows from the pile where it is deposited, along the tops of the furnaces and turned into the receptacles, which are of uniform capacity and open at the tops. These will contain about 7 tons of ore each. After being filled, they are closed hermetically. As the ore becomes sublimated the vapors pass through a series of twelve compartments, entering the one nearest the fire from the top, the second from the bottom, and so on alternating. In their passage through these compartments such of the vapors as become condensed flow in the form of quicksilver through numerous small holes into covered troughs, attached to the outside of the furnaces their entire length, through which the metal is conducted to an iron vat, the size of a half hogshead, sunk into the ground. This is the operation of one furnace. That of the others is in every respect the same. A high degree of heat is not required to smelt the ore, though 680° is necessary to convert the metal into a red oxyd.

Such of the vapor as has not condensed in its passage through the partitions reaches a wooden condenser or reservoir of water, over the surface of which the exhalations pass, and by this contrivance much of the metal not secured in its passage through the furnace-condensers is saved. Each of the furnaces is provided with a large wooden chimney forty feet in height, and from which there are constantly pouring clouds of arsenical vapors, though their quantity is greatly reduced by the precautions now used to prevent their escape; for independent of their deleterious effects, every atom of volatile matter thus dispersed contains its proportion of mercury. The tops of these chimneys are quite coated with cakes of white arsenic, hanging around their mouths like masses of ice about a house spout in winter. At stated periods these are carefully cleaned and the arsenic gathered for chemical uses. The accompanying engraving gives an exact exterior view of one of the furnaces, with the trough for conducting the metal from the condensers into the vat, and the condensing apparatus at the base of the chimneys. . . . *From A Visit to the Quicksilver Mines of New Almaden*, by William V. Wells, in the collection of the California State Library, Sacramento.



SECTION OF CONDENSING FURNACE . . . The [accompanying engraving] represents [a] furnace cut in two lengthwise, revealing the whole internal arrangements; the ore in its receptacle ready for sublimating, the position of the fire, and the apertures connecting the different cells or condensing chambers through which the vapors pass and change into quicksilver . . .

. . . Brickmaking [is] a part of the labor at the works. These are made in the patio at the mouth of the mine, of the siftings which are too fine for the furnaces, owing to its obstructing the passage of the heat through the ore. This is consequently made into adobes, or square bricks, and stored at the hacienda for future use. They are generally submitted to the furnaces during the winter, when the road to the patio is in such bad condition as to retard the travel to and from the mine. They require less heat than the native ore; some of which, however, is introduced into the furnace with them, either to economize or to facilitate the process of smelting . . . From *A Visit to the Quicksilver Mines of New Almaden*, by William V. Wells, in the collection of the California State Library, Sacramento.

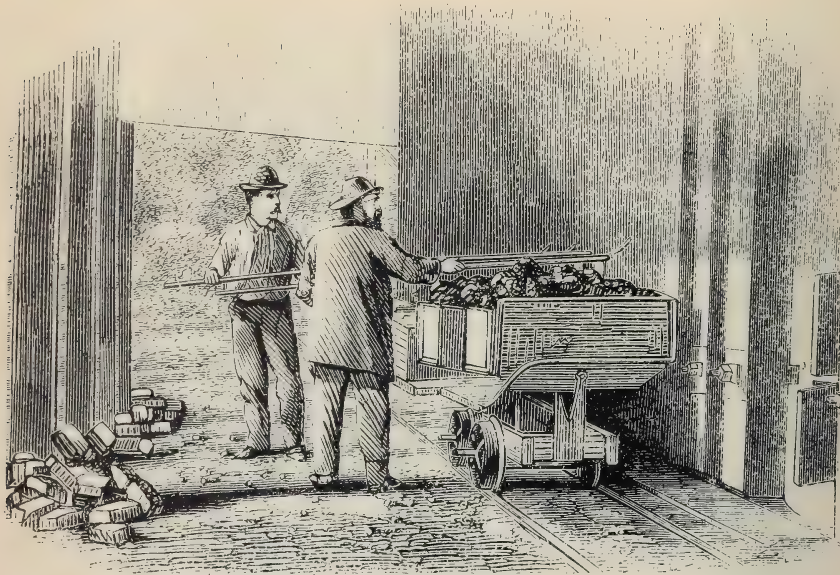


THE REDUCTION WORKS . . . The present Reduction Works consist of six furnaces; five of them possessing a capacity to receive from 70,000 to 80,000 pounds of metal each at a charge. The sixth is a new furnace erected in 1864 on the most approved principles, and is capable of reducing from 150,000 to 200,000 pounds of ore at a charge. The number of charges worked through the furnaces per month varies somewhat according to the weather, but under ordinary circumstances is from four to six.

In the immediate vicinity of the Reduction Works, during the smelting and sublimation of the ores, a noxious odor is perceptible, which has a very pernicious effect upon the nervous system. The workmen who are compelled to stand in close proximity to the furnaces and condensers are frequently salivated, and are liable to palsy, vertigo, and other disorders of the brain; though, of later years, under the improved method of reducing the ores, the health of the operatives is much better than it was in former times. Persons of delicate, nervous organization are peculiarly subject to be injuriously affected by the fumes of mercury. Instances have occurred of ladies, who, in casually passing, became salivated; but the main exit for the vapors having been removed far up the hill, there is now but little danger of bad effects under ordinary circumstances. It is a mistaken idea that the herbage in the vicinity of the Reduction Works is destroyed. Nothing of the kind is perceptible. The vapors soon become dissipated and lose their noxious qualities in the open air. . . . From *Down in the Cinnabar Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.

CHARGING THE FURNACES . . . After undergoing a process of washing, . . . residue (from the sorting) is made into adobes or large bricks, which are dried in the sun; and these are built up in the furnaces, with spaces between them to permit the passage of a draught. Within the adobe stack, thus constructed, the better qualities of ore are carefully arranged so as to receive the greatest possible amount of heat from the fires. . . . From *Down in the Cinnabar Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.

FIRING UP. From *Down in the Cinnabar Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.

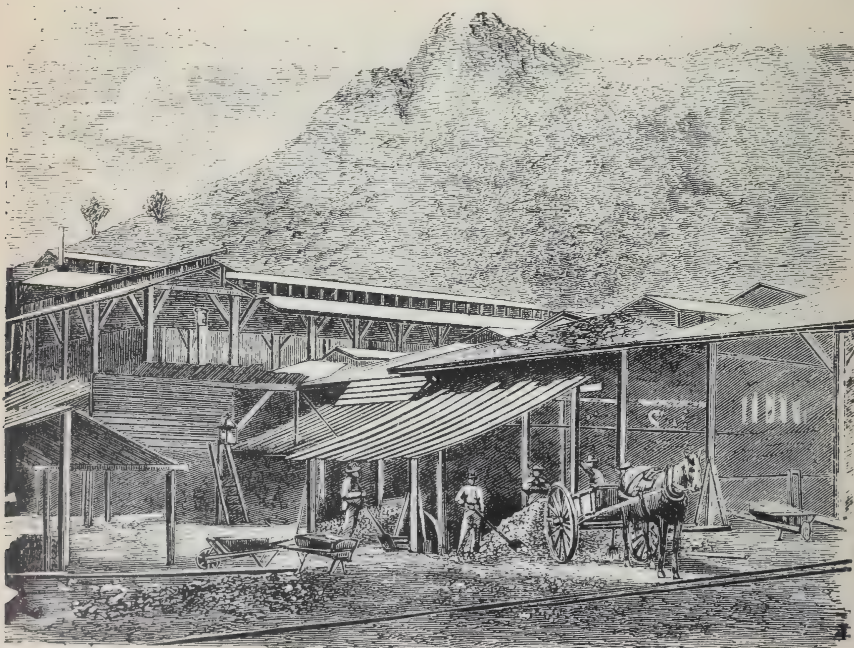


DISCHARGING FURNACES . . . As the quicksilver is deposited or precipitated from the vapors it finds its way into a series of small grooves in the bottom of the condensers. These grooves are slightly inclined, and conduct it into pipes, through which it makes its exit into the large iron pots placed outside for the purpose of receiving it. When the furnaces are in full operation a continuous stream about the thickness of an ordinary quill may be seen pouring into the receiving pots, affording a practical illustration of the mineral wealth of this region. As a rule the quicksilver is deposited in the receiver in a pure state, and is ready to be transferred to the flasks. Sometimes, however, it is covered by a film which requires to be removed. An interesting experiment, showing its buoyant properties, may be made by dipping the hand in the liquid mass. The sensation is peculiar and difficult to explain. Some force is required to sink the hand to the depth of the wrist; and there is a singular feeling that it is pushed up and repelled by some heavy yet impalpable element; for though one is conscious of a surrounding pressure, nothing can be held in the grasp. By gathering up in a handkerchief a few ounces, and squeezing it through the web, a slight idea may be formed of its penetrative qualities. But the most striking illustration of that point has been derived from the practical working of the condensers. A few years ago some boys belonging to the employés discovered near the base of the walls some globules of quicksilver. The young American spirit impelled them to make further explorations, and they soon found by rooting up the ground that the deposit increased in richness as they got under the foundation of the condenser. It was not long before they were enabled to offer to the Superintendent several pounds of quicksilver, for which he paid them a fair price as a reward for their enterprise. Pleased with their success, they continued to work their newly-discovered mine till they began to bring in the quicksilver in such quantities as to open the eyes of the Superintendent. He made an examination of the mine and found that the entire stratum of earth for several feet in thickness, under the condensers, was permeated with the pure metal. Further investigation led to the discovery that this deposit, which yielded many thousands of dollars, had permeated through four feet of solid brick-work, plastered and cemented! Of course immediate means were taken to prevent further wastage. A layer of sheet-iron was placed between the bricks so as to arrest the errant quicksilver and drain it into the regular channels. . . . From *Down in the Quicksilver Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.

FILLING THE FLASKS. From *A Visit to the Quicksilver Mines of New Almaden*, by William V. Wells, in the collection of the California State Library, Sacramento.

PREPARING THE FLASKS. From *Down in the Quicksilver Mines*, by J. Ross Browne, in the collection of the California State Library, Sacramento.

SIDE OF THE MINE PEAK. From *Down in the Quicksilver Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.



SLUICING OLD FURNACE BEDS. From *Down in the Quicksilver Mines,* by J. Ross Browne, in the collection of the California State Library, Sacramento.

all mercurial and arsenical fumes. Before this flue and stack were constructed, even the mules and cattle grazing in the pastures died from the poisonous effects of the mercurial vapour; and its deadly action on vegetation was like that of the fabled upas-tree. The workmen now, as a rule, enjoy very good health, and are admirably cared for; the village boasts a capital hotel, and stages run daily to San José and San Francisco.

R. T. MONTGOMERY

On Discovery in the North *

1858-60

Our little county [Napa] enjoys most of the luxuries afforded by other parts of the State, but in some of them she has shared only to an infinitesimal extent. While Washoe, Gold Bluff, Kern River, and other kindred localities have supped full of enormous "strikes" and astonishing developments, Napa, being only a "cow county," dropped behind in the general current of excitement, and was never, but once, aroused from her customary impassivity as to the enormous mineral resources of this region. However, the good old county could not altogether escape.

In the Winter of 1858-59 there arose an excitement really worthy of the "good times" in the mineral districts. All at once, nobody could very well tell why, a grand silver excitement arose, which permeated the whole community. It was found by various parties that the mountains on the East side of the valley were full of the ores of silver, of untold, because of unknown richness. Simultaneous with this grand discovery, every unemployed man from Soscol to Calistoga turned prospector. Blankets and bacon, beans and hard bread rose to a premium, and the hills were lighted up at night with hundreds of camp-fires. Hammers and picks were in great demand, and there is ocular evidence even to this day that not a bowlder or projecting rock escaped the notice of the prospectors. There was silver in Washoe, why not in Napa. It was a question of probabilities which were bound soon to harden into certainties. Indeed, it was only a short time before silver prospects were possessed of a defined value. Claims were opened, companies formed, and stock issued on the most liberal scale. Everything wore the *couleur de rose*. As usual, upon similar occasions, there was great strife about claims. Some were "jumped" on the ground of some informality twice in twenty-four hours. Heavy prices were paid for "choice" ground, and it is quite safe to say that our mountain sides and summits have never since borne such an enormous valuation. It seemed as though the whole community had been bitten by the mining tarantula. One man, whose name we withhold, in his perambulations in the profound cañons about Mount St. Helena, in company with his son, discovered a ledge of *solid silver*. As neither had brought either blankets or "grub," the old gentleman concluded to stand guard over the precious discovery during the night, armed with a shot-gun, while the son went down into the valley for those indispensable supplies. When morning broke, the old man was still at his post, shot-gun in hand, but tired, sleepy and hungry. The son, laden with food and other inner comforts, "toiled up the sloping steep" with the *de quoi manger* strapped to his back, and both father and son sat down in the gray of the morning, by a hastily lighted fire, to discuss their rude breakfast and the limitless wealth before them. It would not do to leave such an enormous property unguarded. It would be "jumped" in ten minutes. So the shot-gun was transferred to the son, while the father, with an old pair of saddle-bags stuffed

* From *Historical and Descriptive Sketch Book of Napa, Sonoma, Lake and Mendocino, Comprising Sketches of Their Topography, Productions, History, Scenery, and Peculiar Attractions. by C.A. Menefee. Napa City. Reporter Publishing House. 1873;* in the collection of the California State Division of Mines Library.

to repletion with "silver," descended the mountain. His mule soon brought him to Napa, the denizens of which town he was shortly to astonish with his great discovery. He walked up into the *Reporter* office, saddle-bags in hand, opened the fastenings with an exultant smile but a trembling hand, when out fell some brilliant specimens of *iron pyrites*. Alas, that it should be told, but such was the scope and extent of his great silver discovery. But the opinions of the unskilled were of no value. A regular assayer would, of course, tell a different story. And, we suppose, on the principle that the "supply always equals the demand," there were discovered in San Francisco large numbers of "assay offices," at which, for the moderate price of $15, a certificate of quantitative analysis of anything from a brick-bat to a lump of obsidian could be had, showing silver anywhere between $20 and $500 per ton! We were shown numbers of these certificates, and probably gave them all the credence to which they were entitled. There were a few individuals here who had understood from the beginning the character of the whole excitement. One of these, G.N.C., was the recipient of a sample of a very dark pulverized ore of *something*, and, being fond of a joke, dissolved a two-bit piece in nitric acid, and added the resultant to the powdered ore. When the assayer's certificate got back, there was an enormous excitement. The specimen forwarded had yielded $428 to the ton! Of course, when the joke had been duly enjoyed, the secret was revealed, to the great disgust of the lucky proprietors.

Judge S., formerly Sheriff of the county, had been up the valley on business in the muddiest part of the winter, and on his way back met a chap on his way to the "mines." "Have you been to the mines?" said the fellow. "Yes," answered the Sheriff, "but everything is pretty nearly taken up—at least, all the best claims." "But d—n it," said the would-be proprietor, "isn't there anything left?" "Oh, yes," returned the Sheriff, "you *might*, perhaps, get in on some outside claim." Without waiting to make any reply, the fellow clapped spurs to his Rosinante, headed up the valley, and, as the Sheriff declared, "in less than two minutes, you *couldn't see him for the mud he raised*."

The excitement lasted for several weeks, and grew better and better. Scores of men laden with specimens thronged the hotels and saloons, and nothing was talked of but "big strikes" and "astounding developments." A local assay office was started, for the miners could not wait the slow process of sending to San Francisco. It is probable that this local assayer, Mr. Frank McMahon, a very honest and capable man (since engaged about the Knoxville mines), did more than any one man towards pricking the great bubbles of the time. His assays were far less favorable than the imported article, and it came to pass that his customers were dissatisfied with the results of his experiments. Finally, as these threw a shadow of doubt over the value of the argentive discoveries, some of the heavy operators concluded to consult some of the most skillful and well-known assayists of the city—men whose decisions were beyond the reach of suspicion, and whose reputation was above cavil or doubt. Several specimens, considered to be of the highest value, were forwarded. The general disgust of claim owners may be conceived when the formal certificates of assay were returned. Most specimens contained *no silver at all*, and at the best only "*a trace*." Nothing of value had been discovered.—Thereupon ensued a sudden hegira of prospectors to the valley. The millionaires of to-day left their rude camps in the mountains, and, with ragged

breeches and boots out at the toes, subsided at once into despondency and less exciting employments. The hotel and saloon keeps, saying nothing of the editors, proceeded to disencumber their premises of accumulated tons of specimens of all kinds of "shiny rocks" to be found within an area of thirty miles square—making quite a contribution to the paving material of the streets of Napa City. Thus subsided the great mining excitement. The result was that a few were a little poorer, but many hundreds a great deal wiser than they hoped to be. . . . .

. . . . . In 1860 a company of twelve was formed in Napa City for the purpose of prospecting for mines and minerals, and two old pioneer prospectors, Seth Dunham and L.D. Jones, were sent out to examine Napa and the adjacent counties. What might be found was matter of doubt, but the Company, informally organized, concluded to pay a small monthly assessment of $2.50 per month each, in order to find out what might be the resources of the land. The prospectors were wont to bring in, about once a month, the results of their labors. . . . . The Company individually, and the prospectors as well, were well nigh equally ignorant of mineralogy, and the "specimens" brought in ranged from iron pyrites to bituminous shale, all of which were supposed to contain silver. Every newspaper office and hotel bar were replete with these samples of the wealth and value of the mineral resources of the county, all of which, economically considered, were only inferior specimens of macadamizing stone, glistening, but valueless. At last, Messrs. Jones and Dunham, in their perambulations among the hills, struck a new road, then recently built between Berryessa Valley to Lower Lake, and on ascending a hill at the head of Sulphur Cañon, just above the "Elk Horn Ranch;" where the soil and rock had been removed to permit the passage of teams, discovered on the upper side of the road, at the turning point, that the rocky point, partly removed by the road-makers, was of a peculiar color and texture. Fragments broken off were very heavy and of a liver-color. They were brought to town, and by the experts of those times pronounced cinnabar. And such they proved. This first discovery led to the opening of the rich [X.L.C.R., or Redington] mine of which it was but an indication. The ignorant workmen who had constructed the road, had rolled down into the cañon many tons of cinnabar, which would have yielded 50 or 60 per cent. of metal. This discovery led to the opening of this splendid mine, which is now probably only second to the far-famed New Almaden. . . . .

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printed in CALIFORNIA STATE PRINTING OFFICE

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